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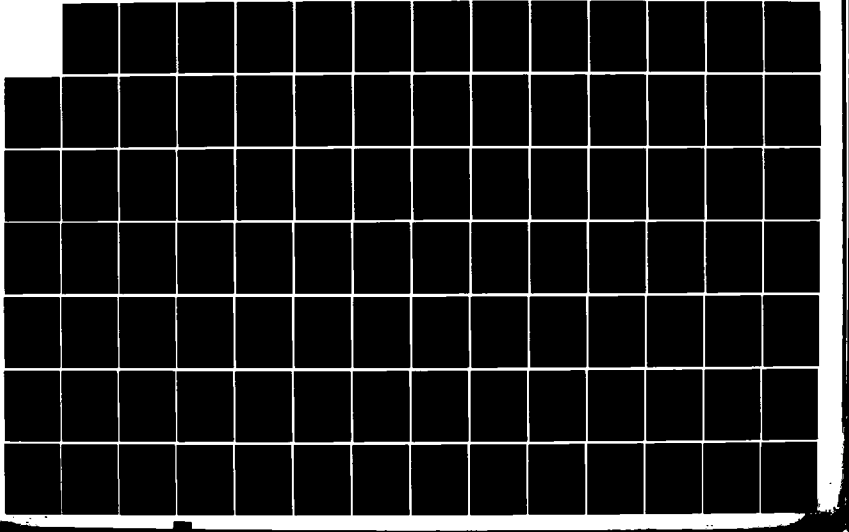

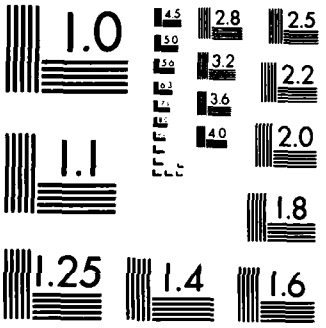

# AN EVALUATION OF THE WSSC COST ALLOCATION ALGORITHMS VII: QUANTITATIVE AND DATA-RELATED TOPICS

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-- STATISTICS --

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## EXECUTIVE SUMMARY

This is the seventh volume in a set of reports which document the findings of a study conducted by Desmatics, Inc. for the Office of VAMOSC, Air Force Logistics Command. This study constituted an assessment of the cost allocation algorithms employed within the Weapon System Support Cost (WSSC) subsystem of the Air Force Visibility and Management of Operating and Support Costs (VAMOSC) system.

The objective of WSSC is to portray the operating and support costs of each major aircraft weapon system in the Air Force inventory. WSSC obtains the majority of its input data from other data systems which provide specially tailored files of cost, manpower, maintenance labor and aircraft flying operations data. Cost data is generally not available by weapon system, making it necessary to allocate shares of common costs to each aircraft on some equitable basis. This allocation of costs is accomplished within WSSC by means of several algorithms which distribute costs using methods appropriate to the type of data available.

The previous six volumes contain the results of Desmatics' evaluation of all the current WSSC cost allocation algorithms. The algorithms are described, and recommendations are made, where appropriate, to change the methodology the WSSC system utilizes. A short summary of each of these volumes is included in this report.

Whereas the first six volumes document the results of a mainly qualitative assessment of the algorithms, this volume attempts to investigate quantitatively some of the topics brought up in previous



volumes. This report also includes additional recommendations based on new information about the WSSC system.

The Cost Analysis Improvement Group (CAIG) guidelines indicate that only variable costs should be portrayed in weapon system costing. Based on this, Desmatics recommended in Volume II that WSSC separate installation support costs into fixed and variable portions. Since costs are not identified as fixed or variable in the accounting system interface to WSSC, the two components may be estimated with a regression procedure. Desmatics applied such a regression procedure to FY81-FY83 WSSC data. However, the results indicated that some anomalies exist in this data and should be examined further.

Flying operations ratios are used to allocate several costs in the WSSC system. Using regression analysis, Desmatics conducted a study to determine the appropriate weights for the variables used in these flying operations ratios. Desmatics has determined that the two variables which comprise this ratio, flying hours and possessed hours, are highly correlated. Because of this situation only one of the variables should be used for allocation, if flying operations ratios continue to be used. The variable which should be used may be determined by a stepwise regression procedure.

WSSC allocates command staff and other unit personnel on the basis of flying operations ratios, but Desmatics has examined two alternative methods for the allocation of these costs. It was found that both flying operations ratios and crew strength ratios give unsatisfactory results when compared to the distribution of such personnel by Program Element Code (PEC). Desmatics recommends that the WSSC system allocate staff

personnel using a process whereby the PEC of an aircraft is matched to the PEC of the staff personnel.

There are a number of significant indirect personnel costs which are not included or are not given separate visibility in WSSC. According to CAIG guidelines these are relevant expenses and should be included. Desmatics recommends costs for military and civilian retirement, dependents' education and civilian permanent change of station (PCS) be added to the WSSC system. These costs, and other indirect personnel costs such as medical care, should be given separate visibility for unit mission personnel on the AF detail output products.

WSSC gets maintenance man-hours for use in allocation of below depot maintenance costs from the D056 system. Desmatics assessed the potential effect of inaccuracies in the maintenance data reported in D056 and concludes that the impact should be minimal.

During the course of its study, Desmatics has found some problems with WSSC input data and the way WSSC utilizes this data. In order to match personnel and costs, many of the WSSC algorithms assume a one-to-one relationship between OAC/OBAN (Operating Agency Code/Operating Budget Account Number) and GELOC (geographic location). Desmatics has learned this is not always the case and recommends this problem be investigated further.

It appears that WSSC is missing relevant costs in some instances and including extraneous costs in others. For example, the OAC/OBAN table is not complete and may contain some incorrect OAC/OBANs. OAC/OBANs should be included in WSSC for all CMD/GELOCs. Some aircraft-

related personnel, who should be included in WSSC, are not because no MDSs are recorded in the AVISURs system at their GELOCs. Since almost all weather services are in support of the Air Force's flying mission, the costs of weather squadrons should also be included in WSSC.

As for extraneous costs, Desmatics has identified a large number of personnel treated as command staff who are not aircraft-related or are at too high a command level to be included in WSSC. The list Desmatics gives is not exhaustive, and this matter should be investigated further.

At this juncture, Desmatics feels that most of the deficiencies in the WSSC system have been identified and evaluated, in this report and in the six preceding volumes. In light of these weaknesses, the present WSSC system cannot be considered a perfect system, which is certainly not unexpected for a relatively new system. However, the WSSC framework, which is well in place, offers the potential for a very useful and necessary cost reporting system, once the steps are taken to correct the existing deficiencies. From a cost-benefit standpoint, Desmatics judges it extremely critical for the Office of VAMOSC to focus on the data selection and processing problems identified in this report.

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# I. INTRODUCTION

Desmatics, Inc., under Contract No. F33600-80-C-0554, is conducting an evaluation of the cost allocation algorithms employed in the Weapon System Support Cost (WSSC) Subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Costs System. The WSSC system is described in three source documents: (1) WSSC User's Manual, AFR 400-31, Volume II [29], (2) WSSC System/Subsystem Specification [15], and (3) VAMOH Preprocessor Subsystem Specification [16].

This report is the seventh in a set of volumes which discuss the scope and findings of the Desmatics evaluation efforts. Whereas the six previous volumes have for the most part concentrated on a qualitative assessment of the WSSC system and its allocation procedures, the current report emphasizes quantitative aspects. Thus, the major topics in this report address the data used or produced by the WSSC system. The data-analytic discussions are complemented by additional findings related to topics covered in the previous six volumes. These findings are based on additional information that has become available since those reports were published.

The following section of this report provides a brief review of the previous six volumes. The succeeding sections present detailed discussions of a number of topics that impact on the WSSC system.

## II. REVIEW OF PREVIOUS VOLUMES

This section contains a review of the previous six volumes in this series of reports. In each volume Desmatics evaluated the WSSC allocation algorithms. Each report contains Desmatics' evaluation, conclusions and recommendations, as well as the Office of VAMOSC's comments. A brief summary of each of the volumes and their recommendations is given below.

### A. VOLUME I - OVERVIEW

This volume [11] discussed the background, objectives and scope of Desmatics' technical effort. It also discussed two topics common to a number of WSSC algorithms. These are (1) the allocation of costs by algorithms based on flying operations ratios and (2) the accuracy of WSSC input data, which comes from existing Air Force data systems. Flying operations ratios are based upon the number of flying hours and possessed hours for each aircraft.

Desmatics recommended (1) a change in the flying operations ratio in order that it provide a consistent allocation of costs, and (2) an evaluation of several of the cost selection processes to determine if the correct costs are chosen and properly classified. The Office of VAMOSC concurred with these recommendations.

## B. VOLUME II - INSTALLATION SUPPORT

This volume [ 7 ] evaluated the WSSC procedures for allocating installation support costs to aircraft weapon systems. WSSC defines Installation Support as Base Operating Support (BOS), Real Property Maintenance (RPM), and Base Communications (COM).

CAIG guidelines call for inclusion of only variable installation support costs, but WSSC input data does not distinguish between fixed and variable costs. Desmatics recommended estimating the fixed component of installation support costs so that it may be removed or displayed separately. The Office of VAMOSC concurred. Estimation of fixed installation support costs is discussed further in Section III.

In Volume II Desmatics also recommended installation support costs be allocated on the basis of personnel strengths rather than a flying operations ratio. The Office of VAMOSC commented that further research needs to be done before implementing this recommendation.

## C. VOLUME III - UNIT OPERATIONS

In this volume [8], Desmatics evaluated the algorithms and data used by WSSC to allocate Unit Operations costs. Unit Operations consists of six major subcategories: aircrew, command staff, security, petroleum, oil and lubricants (POL), training munitions and other unit activity. These categories correspond with the CAIG operating and support cost elements of Unit Mission Personnel and Unit Level Consumption.

Desmatics found, in general, the WSSC algorithms for Unit Opera-

tions provide an adequate means of allocating these costs. Changes were recommended, however, in the way security costs are allocated to the MDS level. Intuitively, security costs do not appear to be driven by the number of flying hours of an MDS. Desmatics recommended that these costs be allocated on the basis of possessed hours only, as opposed to a combination of possessed and flying hours. The Office of VAMOSC concurred.

Desmatics also recommended a methodology be developed to exclude higher level personnel and their costs from WSSC command staff processing. CAIG guidelines indicate only those personnel below the level of Air Division should be costed. The current command staff selection process includes some people at the Air Division, Numbered Air Force and Major Command level. The Office of VAMOSC concurred with this recommendation. Since Volume III was published, Desmatics has further investigated means of excluding higher echelon personnel. Results of this investigation are in Section VII.

## D. VOLUME IV - BELOW DEPOT MAINTENANCE

Below Depot Maintenance is defined as activity performed by unit level personnel which keeps aircraft weapon systems operating and ready to fulfill their mission requirements. The WSSC output format is arranged according to the below depot maintenance organizational structure (Chief of Maintenance, Field Maintenance, etc.). Desmatics recommended in Volume IV [ 9 ] that this be changed to a more functionally oriented

set of reports provides an extensive discussion of this topic. As pointed out in that discussion, if it is desired to have both FH and PH used as allocation variables, the allocated costs should be proportional to pFH + (1-p)PH, where $0 \leq p \leq 1$.

As part of the Desmatics research, it was assumed that both PH and FH were prime candidates as allocation variables. Based on this assumption, a quantitative investigation was conducted of five WSSC cost categories to examine

(1) whether one or both of these variables should be used in allocation, and

(2) if both are required, what the appropriate weighting between them should be.

Table 2 lists those WSSC categories which originally used FH and/or PH as allocation variables. The five categories analyzed and discussed in the following subsections are POL, Security, General Depot Support, Replenishment Spares, and Depot Maintenance. The remaining categories are not discussed in this section for a variety of reasons. Command Staff and Other Unit Personnel are discussed in a separate section of this report, as is Installation Support. The discussion pertaining to Installation Support is also pertinent to Depot Installation Support. Medical cost allocation is no longer based on aircraft operations data, and not enough data was available for Modification Kits to permit an analysis.

As pointed out previously [11], with aggregate data for a number of years, a regression approach may be used as a basis for an investigation of the relative weighting of FH and PH. A more detailed dis-

fore, it is necessary for WSSC to allocate the costs to the desired level. The lowest level at which cost allocations are required is the CMD/GELOC/MDS level.

As one example, consider the POL cost category. In this category the costs at the MDS level are "actual," i.e., as recorded in the Air Force D022A data system. The costs at the MDS level must be allocated to the CMD/GELOC/MDS level. For other cost categories, allocations to the CMD/GELOC/MDS level are required from different aggregate levels. For the security cost category, for instance, actual costs are known at the CMD/GELOC level.

In most cost allocation situations in accounting, the usual procedure is to select a single allocation variable (i.e., the major "cost driver") thought to have a causal relationship to the costs being allocated, and to apportion aggregate costs at a given lower level in proportion to the value of the allocation variable. Sometimes the allocation variable is obvious. In other cases there may be a number of possible candidates, but usually the one thought most reasonable is selected.

The WSSC system evolved from the Operating and Support Cost Estimating Reference (OSCER) system which was initially designed and placed in operation in the mid-1970's. In the OSCER system many cost allocations used FH as the allocation variable. However, for some reason the WSSC system was designed to use both FH and PH in many of the same allocations. Unfortunately, the allocation procedures which incorporated both these variables were theoretically incorrect, violating the reasonable requirement of internal consistency. A previous volume [11] in this

## IV. THE USE OF FLYING OPERATIONS RATIOS IN ALLOCATION

Many WSSC algorithms use flying operations ratios, which involve flying hours (FH) and possessed hours (PH), for their allocations. To some extent the investigation of appropriate flying operations ratios is a moot topic, because Desmatics has recommended more appropriate allocation procedures in most cases. Nonetheless, the flying operations ratios originally designed into the system are still being used.

This section discusses Desmatics' investigation of the appropriate weighting for FH and PH, if allocations are to be based on them. Using three years (FY81, FY82, and FY83) of WSSC data, Desmatics applied stepwise regression in this study. Stepwise regression is a statistical procedure which permits variables (in this case, FH and PH) to be considered in order of their relative importance in the relationship with the cost to be allocated.

The results of this investigation revealed that both FH and PH are not required in the allocations; one of these two variables alone will suffice, as the two are highly correlated. In fact, a composite allocation formula involving both FH and PH results in a more complex allocation procedure with no corresponding gain in allocation accuracy.

### A. BACKGROUND

The WSSC system deals with a number of cost categories. In general, the costs within these categories are known at some aggregate level. However the distribution of these costs at a lower level is needed. There-

illustrate the fact that there are some problems with the WSSC data. In FY83, supported strengths and total base populations are greater than in FY82 when summed over the 101 bases. COM costs, on the other hand, decrease by 32%. These figures do not seem reasonable. It is clear that no methodology for estimating fixed costs can be successful until these data anomalies are corrected. Section VII of this report discusses some of the possible causes of these data problems.

| FY | Total Supported Strength | Total Base Population | Total COM Costs FY83 $ |
|---|---|---|---|
| 81 | 433,803 | 600,904 | 417.3 M |
| 82 | 458,223 | 633,508 | 413.4 M |
| 83 | 474,733 | 641,899 | 281.5 M |

Table 1. Total Supported Strengths, Base Populations, and COM Costs for 101 Bases.

is the average total cost for that base over FY81-FY83. This is an estimate of the fixed cost for that particular base.

## C. RESULTS

In order to apply the fixed cost estimation methodology, Desmatics used FY81-FY83 WSSC data. Installation support cost and personnel data was analyzed for 101 bases. In order to be considered in the analysis, a base had to appear in all three years of the data. Each of the cost elements, BOS, RPM, and COM, was considered separately (i.e., a separate fixed cost was calculated for each type of cost). The costs for FY81 and FY82 were inflated to an FY83 basis using the factors from AFR 173-13 [25] for Operations and Maintenance costs.

Desmatics attempted to apply the three-step approach outlined in the previous section to data for the 101 bases described above. However, immediate difficulties were encountered when applying the first step of the process. Fitting separate linear regression functions for COM for the 101 bases yielded 91 negative slopes. This implies that for the majority of bases COM costs are inversely related to supported strength. This conclusion is obviously unreasonable and there must therefore be a problem with either the data or the estimation process. Attempts to apply the methodology to BOS and RPM costs led to similar (but less extreme) negative results.

Table 1 lists supported strengths, total base population and COM costs for FY81-FY83. These values are summed over all 101 bases used in these analyses. The costs are given in FY83 dollars. These totals

may be seen from the figure that, over a small range of possible supported strength ($X_i$) values, the model curve is well approximated by a straight line. Since the percentage change in strengths from year to year at a given base is small, the linear approximation should be adequate for the three years of data currently available from WSSC. These lines may be fit for each base, yielding a set of estimated slopes $\{\hat{B}_i\}$.

The slope of the model curve at a point X is given by $\alpha \cdot \beta \cdot X^{\beta-1}$. The next step in this process is to match the linear slopes with the theoretical model slopes in order to estimate $\alpha$ and $\beta$. In order to do this, one may calculate the average supported strength over FY81-FY83 for each base. These quantities may be denoted by $\bar{X}_i$ for base i. The following model may then be fit:

$$\hat{B}_i = (\alpha \cdot \beta) \cdot \bar{X}_i^{\beta-1}. \qquad (2)$$

Taking logs of both sides, one obtains:

$$\log(\hat{B}_i) = \log(\alpha \cdot \beta) + (\beta-1)\log(\bar{X}_i),$$

which is a simple linear regression model. Simple algebraic manipulation of the resulting parameter estimates yield estimates for $\alpha$ and $\beta$, $\hat{\alpha}$ and $\hat{\beta}$, respectively.

Finally, using equation (1), given the estimates $\hat{\alpha}$ and $\hat{\beta}$ from equation (2), one may calculate $\overline{TC}_i - \hat{\alpha}\bar{X}_i^{\hat{\beta}}$ for each base, where $\overline{TC}_i$

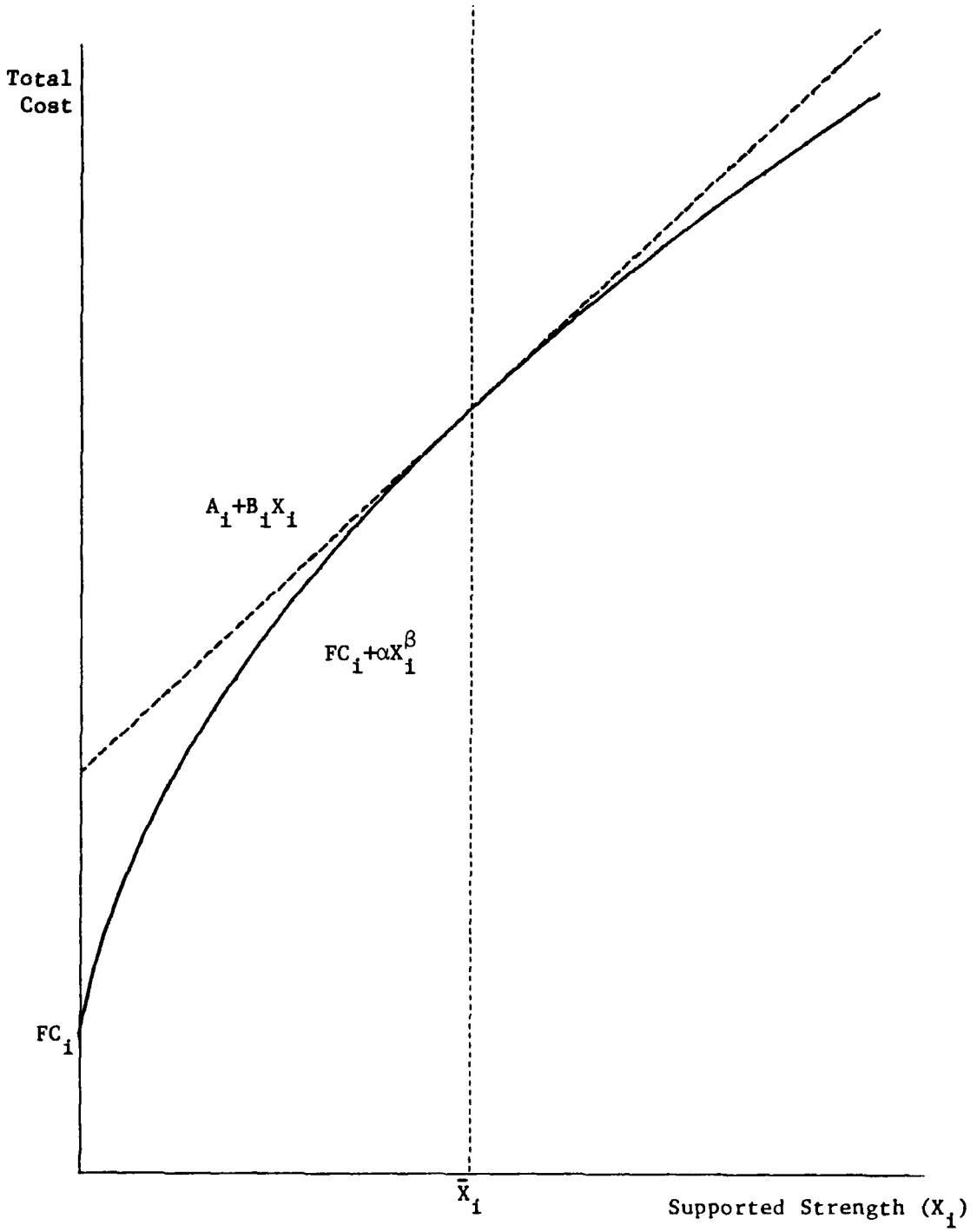


Figure 1: Model Used for Isolating Fixed Installation Support Costs and Linear Approximation to the Model.

An important additional assumption is made when this model is fit to the data. It is assumed that although fixed costs may vary from base to base, any increments in installation support costs due to the variable components are incurred according to the same general relationship for all bases. In terms of the model, this implies that FC is estimated separately for each base but the parameters $\alpha$ and $\beta$ are estimated using data from all bases.

The model described above is nonlinear (not a linear function of the parameters). Unfortunately, nonlinear regression usually presents severe computational difficulties. There is no formula which allows one to obtain optimal parameter estimates directly. It is necessary to use a computer-aided search routine in order to select those values for the parameters which result in the best agreement between the hypothetical model and the observed data. For the present situation, this entails a simultaneous search over the possible values of more than 100 parameters. Desmatics found that it was not computationally feasible to fit this model directly. However, an alternative method can be used to estimate the parameters. Figure 1 illustrates the model for a given base i, along with the linear approximation to the model at the point labeled $\bar{X}_i$. As can be seen from its relationship to the straight line, the model curve has a constantly decreasing slope. This reflects the economies of scale which were part of the reason for selecting this particular model.

Although the model chosen may not be fit to the data directly, its parameters may be estimated using a three-step process. First, it

total costs. In order to apply these techniques, Desmatics assumes that, for any given base, as supported strength increases, the corresponding variable support costs also increase according to some reasonable relationship. This assumption appears intuitively reasonable, and is supported by several studies (e.g., [12], [13]). Regression is a means of approximating this relationship between costs and supported strength.

Based on the assumption that support costs are a function of the supported strength, a mathematical model may be used to describe each of the elements of installation support costs (BOS, RPM, COM). A reasonable model for the total cost is given by:

$$TC_i = FC_i + \alpha X_i^{\beta} \qquad (1)$$

where $TC_i$ = *total support cost for a particular element of installation support for base i,*

$FC_i$ = fixed cost for that element for base i, which is unknown and must be estimated,

$X_i$ = supported strength at base i,

and $\alpha$ and $\beta$ are parameters which must be estimated.

The term $\alpha X_i^{\beta}$ describes the variable portion of the particular cost element. This model is simple, flexible, and is reasonable from an economic and accounting standpoint. It reflects the additive nature of fixed and variable costs and allows for economies of scale. While the model is not expected to completely describe the relationship between support costs and supported strength, it should provide a reasonable approximation to that relationship.

## A. FIXED AND VARIABLE INDIRECT COSTS

Indirect costs are composed of fixed and variable portions. The Air Force is required by Department of Defense MBO 9-2 [ 5 ] to develop a system to identify cost elements which taken as a whole "... describe the total variable cost to DOD of operating and supporting the weapon system ...." It is necessary to isolate variable costs in order to compare data for existing and proposed systems. The CAIG [ 3 ] indicates that installation support costs which are incurred by the host on behalf of a weapon system should be included in weapon system accounting only if they would not be incurred by the host were the weapon system moved elsewhere (i.e., only if they are variable costs).

There is no clean line separating the fixed costs from the variable costs associated with installation support. There is no direct way of measuring each of these components separately. At best, only estimates of the fixed and variable portions of the total installation support costs can be computed. The next section discusses Desmatics' approach to this estimation problem.

## B. ESTIMATING FIXED AND VARIABLE INSTALLATION SUPPORT COSTS

Since fixed and variable indirect costs are not tracked separately by the Air Force accounting system, it is necessary to estimate the portion of total costs that each represents. Statistical regression techniques may be used to provide visibility of these two components of the

## III. THE IDENTIFICATION OF FIXED INSTALLATION SUPPORT COSTS

In Volume II of this series of reports, Desmatics recommended the use of statistical techniques to estimate the fixed component of installation support costs. Installation support includes the costs of manpower, materiel and services required for the operation of an Air Force base. They are incurred by the host organization, primarily for the benefit of its tenant organizations, and are generally referred to as overhead or indirect costs. WSSC defines installation support in terms of three components:

(1) Base Operating Support (BOS) - PEC xxx96,

(2) Real Property Maintenance (RPM) - PEC xxx94,

and (3) Base Communications (COM) - PECs xxx95, 33112 (with RC/CC xx26xx or xx38xx), & 35114 (with RC/CC xx26xx or xx38xx).

The following sections reiterate the reasons for isolating fixed support costs, describe the methodology employed by Desmatics to estimate those fixed costs, and discuss the results of the estimation process. Unfortunately, those results do not provide a reasonable description of cost behavior. Further investigation by Desmatics revealed anomalies in the data provided by WSSC for installation support. This impairs Desmatics' analysis effort in the area of fixed installation support cost estimation, but does not vitiate the theoretical approach to such estimation. Possible reasons for the data anomalies are discussed in Section VII.

## F. VOLUME VI - PERSONNEL RELATED CATEGORIES

Volume VI [32] discussed indirect personnel support costs, which include medical care and permanent change of station (PCS). This category also includes personnel acquisition and training, advanced training and advanced flying training, but the Office of VAMOSC has not yet implemented algorithms for these.

After evaluating the input data and algorithm used to allocate medical care costs, Desmatics concluded that the algorithm was sound, but costs for dental care and dependents' medical care should also be included. The Office of VAMOSC concurred. Desmatics also recommended average PCS costs for civilian personnel be developed and allocated along with military PCS costs. This would conform more closely with CAIG guidelines. Currently, civilian PCS costs in WSSC are embedded in Base Operating Support. The Office of VAMOSC did not concur, stating that there are insufficient civilian PCS moves for the Air Force Accounting and Finance Center (AFAFC) to justify developing average costs.

The proposed algorithm for allocating personnel acquisition and training costs was found to be reasonable provided the Program Element Code (PEC) of the personnel could be matched to the PEC of the aircraft MDS at the base. The Office of VAMOSC concurred.

set of categories (e.g., airframe, engine, accessories, etc.). This would give more useful information about the kinds of maintenance which are performed on an MDS, and would also conform more closely with the CAIG format. The Office of VAMOSC concurred.

## E. *VOLUME V - DEPOT LEVEL CATEGORIES*

In this volume [10] Desmatics evaluated the algorithms and data used to allocate the costs of the Air Force Logistics Command (AFLC) depots. WSSC groups these costs into four categories: 1) Depot Maintenance, 2) General Depot Support, 3) Depot Installation Support, and 4) Sustaining Investment.

Several recommendations were made to improve these allocations. Depot Maintenance, General Depot Support, and Depot Installation Support costs should be allocated on the basis of completion ratios rather than flying operations ratios. Completion ratios are a measure of the depot maintenance required on a weapon system's airframe.

As with base installation support, a fixed component of depot installation support should be identified and either displayed separately or removed. Desmatics also recommended costs for the Directorates of Procurement, Materiel Management, and Distribution be included when allocating Depot Installation Support. At present, the WSSC system includes only the Directorate of Maintenance in this category. The Office of VAMOSC concurred with these recommendations.

| Category | Allocation Variables Used |
|---|---|
| Command Staff | FH,PH |
| Other Unit Personnel | FH,PH |
| Medical | FH,PH |
| POL | FH |
| Sustaining Investment | |
| Replenishment Spares | FH,PH |
| Modification Kits | PH |
| Depot Maintenance | FH,PH |
| General Depot Support | FH,PH |
| Depot Installation Support | FH,PH |
| Installation Support | FH,PH |
| Aircraft Security | FH,PH |

Table 2: WSSC Categories Which Originally Used FH and/or PH As Allocation Variables

cussion of such a regression approach also recently appeared in the cost allocation literature [31]. The procedure used by Desmatics in its research is discussed in the following section.

## B. UNDERLYING MATHEMATICAL AND STATISTICAL FRAMEWORK

To provide a walk-through of the mathematical underpinnings of the approach used, the POL category will be used. Of course, FH is intuitively the logical choice for allocation of POL costs and, in fact, WSSC only uses FH. For example, if one F4E flies twice as much as another, it would probably consume roughly twice as much fuel, and hence twice as much cost.

As previously stated, POL costs are available at the MDS level and must be allocated to the CMD/GELOC/MDS level. The WSSC system currently contains reported (i.e., actual) POL costs for each MDS for each of FY81, FY82 and FY83. Let

$y_{ijk}$ = POL costs for MDS i at CMD/GELOC j in FY k

$x_{ijk}$ = FH for MDS i at CMD/GELOC j in FY k

$z_{ijk}$ = PH for MDS i at CMD/GELOC j in FY k

$\beta_i$ = cost per FH for MDS i

$\gamma_i$ = cost per PH for MDS i.

When both FH and PH are used as allocation variables, the following proportionality holds:

$$y_{ijk} \propto p_i x_{ijk} + (1-p_i) z_{ijk}.$$

This proportionality can, of course, be made into an equality by using an unknown proportionality constant $C_i$. Thus,

$$y_{ijk} = C_i[p_i x_{ijk} + (1-p_i) z_{ijk}]$$

which may be rewritten as

$$y_{ijk} = \beta_i x_{ijk} + \gamma_i z_{ijk} \tag{3}$$

where $\beta_i = C_i p_i$ and $\gamma_i = C_i(1-p_i)$. (4)

Equation (3) may be regarded as a regression model if three underlying assumptions are made. These are:

(1) $y_{ijk}$ denotes variable costs (*i.e., if* $x_{ijk}=z_{ijk}=0$, then $y_{ijk}=0$).

(2) $y_{ijk}$ is in constant dollars (i.e., a correction for inflation has been made).

(3) The functional form given in (3) is correct or a good approximation.

It should be noted that in equation (3) $\beta_i$ and $\gamma_i$ are parameters with unknown values, while $x_{ijk}$ and $z_{ijk}$ are random variables with known (observed) values. Although $y_{ijk}$ is a random variable, its value is unobservable as costs are not available at that level. However, its summation over j (i.e., over CMD/GELOC) is observable.

Now, let $Y_{ik} = \sum_j y_{ijk}$, $X_{ik} = \sum_j x_{ijk}$, and $Z_{ik} = \sum_j z_{ijk}$.

Thus,

$Y_{ik}$ = total POL costs for MDS i in FY k

$X_{ik}$ = total FH for MDS i in FY k

$Z_{ik}$ = total PH for MDS i in FY k.

The following set of equations (written in matrix notation) may be solved for $\beta_i$ and $\gamma_i$, i=1, ..., I:

$$\underline{Y} = \underline{X\beta} + \underline{Z\gamma} \tag{5}$$

where

$$\underline{Y}_{3I\times 1} = (Y_{11}, Y_{12}, Y_{13}, Y_{21}, Y_{22}, Y_{23}, \ldots, Y_{I1}, Y_{I2}, Y_{I3})'$$

$$\underline{X}_{3I\times I} = \begin{bmatrix} X_{11} & & \\ X_{12} & \underline{0} & \underline{0} \\ X_{13} & & \\ & X_{21} & \\ \underline{0} & X_{22} & \underline{0} \\ & X_{23} & \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ & & X_{I1} \\ \underline{0} & \underline{0} & X_{I2} \\ & & X_{I3} \end{bmatrix}$$

$$\underset{3I\times I}{Z} = \begin{bmatrix} z_{11} & & \\ z_{12} & \underline{0} & \underline{0} \\ z_{13} & & \\ & z_{21} & \\ \underline{0} & z_{22} & \underline{0} \\ & z_{23} & \\ \cdot & & \cdot \\ \cdot & & \cdot \\ \cdot & & \cdot \\ & & z_{I1} \\ \underline{0} & \underline{0} & z_{I2} \\ & & z_{I3} \end{bmatrix}$$

$$\underset{I\times 1}{\beta} = (\beta_1, \beta_2, \ldots, \beta_I)'$$

and $$\underset{I\times 1}{\gamma} = (\gamma_1, \gamma_2, \ldots, \gamma_I)'.$$

Based on this regression framework, the initial step in the Desmatics research investigation was to ascertain if, in fact, a single allocation variable (either FH or PH) would suffice. To do this, a stepwise regression procedure was used in which the initial variable fit in the regression model was the one that accounted for the larger sum of squares in the associated analysis of variance. (Thus, either the submodel $\underline{Y}=\underline{X\beta}$ or $\underline{Y}=\underline{Z\gamma}$ was fit.)

The remaining variable was then added to the model to determine whether it accounted for a statistically significant portion of the residual sum of squares. If it did not, this implies that only one

allocation variable (the first selected) is required. On the other hand, if the second variable did provide a statistically significant result, this implies that both FH and PH should be used as allocation variables. Their allocation weights (e.g., $\beta_i$ and $\gamma_i$) may then be estimated from the data.

C. POL

WSSC POL cost, FH and PH data for FY81, FY82 and FY83 was obtained for 102 MDSs (at the worldwide level). Desmatics used a stepwise procedure to fit regression model (5) to this data. The results are summarized in the following analysis of variance table.

| Source | Contribution to Sum of Squares | Probability Value |
|---|---|---|
| FH | 99.7% | <.001 |
| PH\|FH | 0.1% | .974 |
| Error | 0.2% | |
| Total | 100.0% | |

The first line of entries in this table indicates that FH was selected as the variable to be used in the first step of the regression procedure because it contributed a larger sum of squares than did PH. It also provides the information that FH, by itself, accounted for 99.7% of the total sum of squares, which is statistically significant based on a standard F-test. The probability values listed are those resulting from the F-test. Values smaller than .05 indicate statistically significant results.

The notation PH|FH in the second line of the table indicates that the variable PH was added into the model with FH already in it. As can be seen, the addition of PH to the model accounted for only an additional 0.1% of the total sum of squares. Based on the observed probability value of less than .001 for FH and .974 for PH|FH, the strong conclusion is that FH alone should be used for allocation of POL from the MDS level to the CMD/GELOC/MDS level. This result, of course, confirms what would be expected on purely intuitive grounds, and thus lends credence to the data analytic approach that was adopted.

D. AIRCRAFT SECURITY

WSSC aircraft security cost, FH and PH data for FY81, FY82, and FY83 was obtained for 71 CMD/GELOCs. A stepwise procedure similar to that used in the analysis of the POL data produced the following results:

| Source | Contribution to Sum of Squares | Probability Value |
|---|---|---|
| PH | 96.0% | <.001 |
| FH\|PH | 2.2% | .231 |
| Error | 1.8% | |
| Total | 100.0% | |

As the entries in this table indicate, the results of the data analysis point out that for allocation of aircraft security costs from the CMD/GELOC level to the CMD/GELOC/MDS level, only PH should be used. Again intuition is supported by the data: aircraft security costs should be

allocated based on the number of aircraft (i.e., possessed hours) alone, with no use made of FH as an allocation variable. Based on a previous recommendation by Desmatics (see Volume III [ 8 ]), the Office of VAMOSC incorporated a change to PH alone into the WSSC system.

## E. GENERAL DEPOT SUPPORT

WSSC General Depot Support cost, FH and PH data for FY81, FY82 and FY83 was obtained for the worldwide level. Thus, for this category only a total of three data points was available. The results of the stepwise regression procedure are given in the following table:

| Source | Contribution to Sum of Squares | Probability Value |
|---|---|---|
| PH | 100.0% | <.001 |
| FH\|PH | 0.0% | .503 |
| Error | 0.0% | |
| Total | 100.0% | |

Thus, for General Depot Support costs, these results strongly suggest allocation from the worldwide level to CMD/GELOC/MDS level based on PH alone. Intuition here is not clear that, if choosing between PH, FH or both, the choice should be PH by itself. However, since General Depot Support costs are those associated with materiel management, distribution, and engineering services, a case could be built for a much more direct relationship of the costs to number of aircraft than to number of flying hours.

F. REPLENISHMENT SPARES

WSSC Replenishment Spares cost, FH and PH data for FY81, FY82 and FY83 was obtained from the 15 MDSs for which the three year's data was available. The stepwise regression procedure produced the following results:

| Source | Contribution to Sum of Squares | Probability Value |
|---|---|---|
| PH | 76.3% | <.001 |
| FH\|PH | 18.8% | .007 |
| Error | 4.9% | |
| Total | 100.0% | |

In this case, unlike the three previously discussed, the addition of FH to a model which already includes PH does produce a statistically signficant result, and accounts for an additional 18.8% of the total sum of squares. This, of course, indicates that both FH and PH should be used as allocation variables. That is, Replenishment Spares costs should be allocated in proportion to $p_i FH+(1-p_i)PH$ for any given MDS i. From (4) it can be seen that $p_i$ is proportional to $\beta_i$ and $1-p_i$ is proportional to $\gamma_i$. Since both $p_i$ and $(1-p_i)$ are assumed to be restricted to the interval (0,1), this implies that both $\beta_i$ and $\gamma_i$ should be non-negative.

Table 3 provides a list of the values of $\hat{\beta}_i$ and $\hat{\gamma}_i$ for each of the 15 MDSs examined. As can be seen from the table, there are many negative estimates. This provides a counterintuitive situation, since it results

| $\hat{\beta}_i$ (estimated FH weight) | $\hat{\gamma}_i$ (estimated PH weight) |
|---|---|
| -0.415 | 0.139 |
| -0.584 | 0.082 |
| 0.211 | -0.014 |
| -1.201 | 0.207 |
| 0.076 | -0.003 |
| -11.188 | 0.392 |
| -40.112 | 1.314 |
| -16.810 | 0.581 |
| 1.944 | -0.069 |
| 3.896 | -0.090 |
| -0.687 | 0.030 |
| -4.962 | 0.179 |
| -53.089 | 1.540 |
| -0.073 | 0.004 |
| 1.729 | -0.218 |

Table 3: Estimated Values of the Allocation Weights $\beta_i$ and $\gamma_i$ for the 15 MDSs Used in the Examination of Replenishment Spares Costs

in either possessed hours or flying hours receiving a negative weight. This says, in essence, that allocated costs should be reduced for each additional PH (or FH). Conceivably, then, a CMD/GELOC/MDS could be allocated a negative portion of Replenishment Spares costs. The major reason for this nonsense result is data multicollinearity. The topic of multicollinearity and its impact on this analysis of the WSSC data will be discussed later in this report. In brief, however, the unanticipated negative estimates result from relatively high correlation between FH and PH.

In view of the negative estimates, Desmatics considers it inadvisable to attempt to use both FH and PH in allocating costs for Replenishment Spares. Instead, if replenishment spares allocations are to be based on flying operations data, only the more significant of these variables (PH) be used.

## G. DEPOT MAINTENANCE

WSSC Depot Maintenance cost, FH and PH data for FY81, FY82 and FY83 was obtained for 90 MDSs. The results of the stepwise regression procedure are given in the following table:

| Source | Contribution to Sum of Squares | Probability Value |
|---|---|---|
| FH | 80.4% | <.001 |
| PH\|FH | 13.9% | <.001 |
| Error | 5.7% | |
| Total | 100.0% | |

Again, as in the case of Replenishment Spares, the data indicates that both FH and PH should be used as allocation variables. However, here also, many negative $\beta_i$ and $\gamma_i$ estimates resulted. Thus, Desmatics recommends that if depot maintenance allocations are to be based on flying operations data, use FH only.

## H. DATA MULTICOLLINEARITY AND NEGATIVE ESTIMATES

In general, data multicollinearity occurs when the independent variables (such as FH and PH) used in a multiple regression are highly correlated. In such cases the estimates of regression coefficients tend to be imprecise, often having the wrong sign (e.g., negative costs). Very little new information is provided by knowing the values of both independent variables instead of just one. In general, the problem of multicollinearity indicates that the regression model being used is overspecified [6]. The most straightforward solution is to simplify the model, for example by eliminating one of the independent variables.

Data multicollinearity is a serious problem in the FH-PH data, as can be seen from Figure 2 which presents a histogram of sample correlation coefficients between FH and PH. These are for the MDSs used in the investigation of the Depot Maintenance allocation in the previous section. The figure reflects the fact that the majority of sample correlations lie in the interval .8 to 1.0, indicating an overspecified model. Thus, as mentioned in the previous section, the most feasible approach for Depot Maintenance is to select the more significant vari-

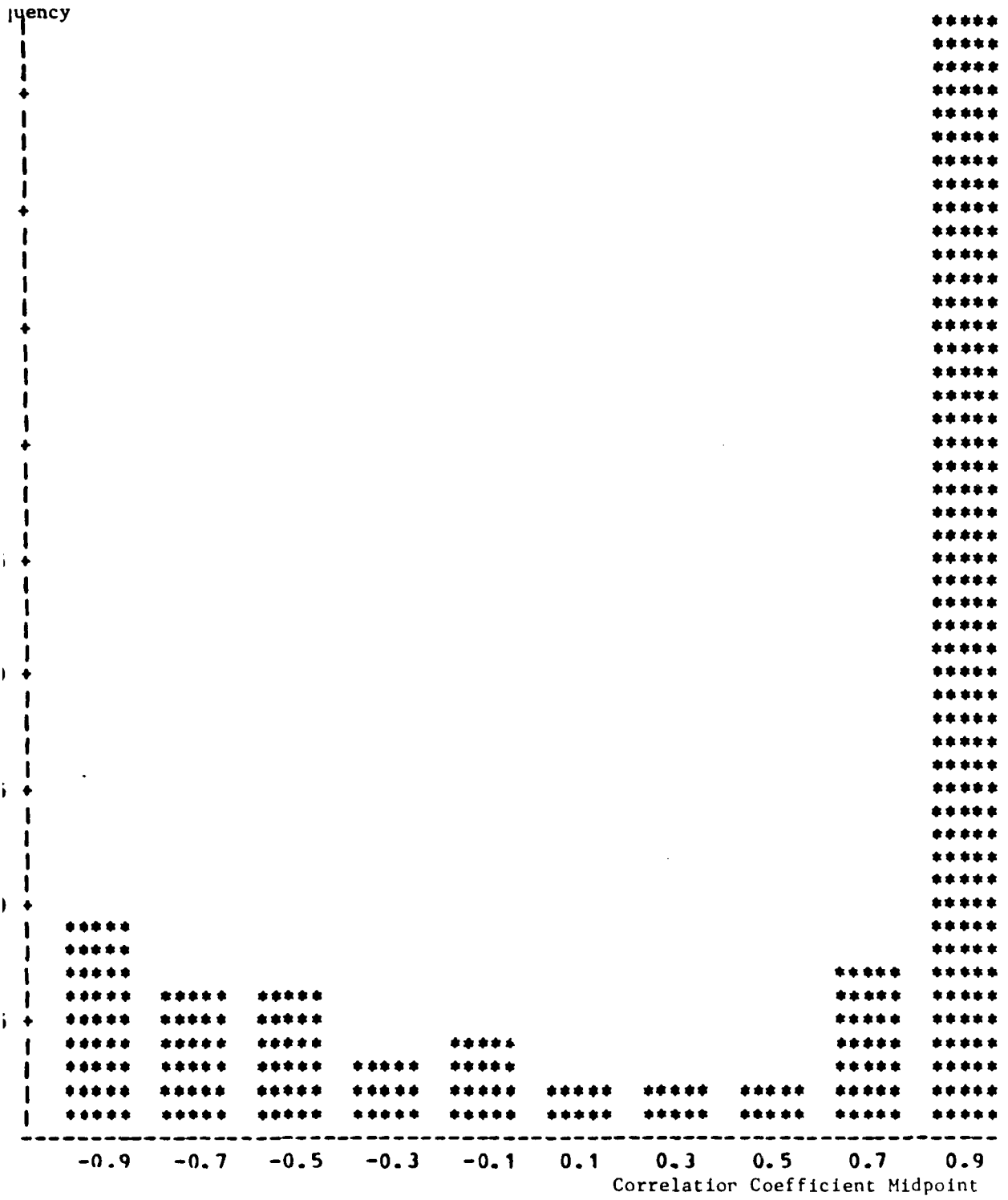


Figure 2: Histogram of Sample Correlation Coefficients Between FH and PH for the MDSs in the Depot Maintenance Allocation

able (FH), and use that alone for an allocation basis.

Multicollinearity and the associated difficulties also arise for FH-PH data when the other cost categories are considered. Therefore, Desmatics recommends that if flying operations ratios (involving FH and PH) are to be used in allocation, then only that variable which proves most significant be selected. Since costs based on FH and PH as allocation variables are allocated proportional to pFH+(1-p)PH, the parameter p will be set equal to either 0 or 1 for any cost category.

file which is input to VAMOH contains PEC data. Desmatics examined some detailed AVISURS data and was able to match MDSs quite well with FY83 MPC personnel records on the basis of PEC.

This refined PEC-matching technique will generally permit unique association of over 90% of the command staff and other unit personnel to at least the MD level. The remaining personnel are in PECs which indicate that the personnel are in support of aircraft, but the specific MDSs cannot be determined. These personnel need to be allocated to the MDS level.

Another type of situation requiring allocation occurs when two or more MDSs are reported in AVISURS with the same PEC. The most common examples involve aircraft of the same Mission-Design, but of different series (e.g., B52D/B52H), when assigned to the same CMD/GELOC. Desmatics recommends using possessed hours to do the final stage of allocation to the MDS level in both instances.

Another problem situation encountered by Desmatics occurs when an MDS at a particular CMD/GELOC is reported in AVISURS under two PECs. In such situations Desmatics recommends first allocating personnel by PEC to aircraft at the CMD/GELOC/PEC/MDS level (using possessed hours to allocate among any MDSs having the same PEC), and then summing over PECs to the CMD/GELOC/MDS level.

In summary, Desmatics used a PEC/MD association technique to approximate the true distribution of command staff personnel to air-

Each of these test statistics has a chi-square distribution with 34 degrees of freedom if the hypothesis is true. As shown by the p values, it is obvious that neither allocation is close to the PEC allocation.

## D. RECOMMENDED ALTERNATIVE FOR STAFF ALLOCATION

The foregoing statistical analysis of command staff and other unit personnel data indicates quite clearly that neither flying operations ratios nor crew strength ratios provide satisfactory allocations in all of the situations examined by Desmatics. It is apparent that an alternative is needed.

The use of Program Element Codes to identify staff personnel with MDSs was initially considered solely as a research tool which might be applicable in a limited set of situations. However, in view of the shortcomings of the flying operations and crew strength ratios, Desmatics has reconsidered the use of PECs as a mechanism for associating staff personnel subgroups with MDSs.

The technique used in this study to associate PECs with MDSs hinged on finding bases having staff personnel in PECs for which the descriptions in AFR 300-4, ADE PR-570 [22], specifically mention an MD. A variation of that original PEC/MD technique promises a better solution. This involves matching aircraft records at the MDS level from AVISURS with staff personnel records from MPC using program element codes for the aircraft as well as the personnel. Although the AVISURS files which are currently passed from VAMOH to WSSC lack PEC information, the AVISURS

| GELOC | CMD | #MDs | Crew vs PEC $\chi^2$ | Crew vs PEC p | Flying Operations vs PEC $\chi^2$ | Flying Operations vs PEC p |
|---|---|---|---|---|---|---|
| AEDY | AFE | 2 | 0.12 | .7294 | 4.46 | .0347 |
| AJJY | SAC | 2 | 0.48 | .4861 | 11.03 | .0009 |
| AWUB | SAC | 3 | 9.35 | .0093 | 28.91 | <.0001 |
| BWKR | SAC | 2 | 5.32 | .0211 | 11.28 | .0008 |
| DDPF | SAC | 2 | 3.03 | .0817 | 3.79 | .0515 |
| DESR | SAC | 2 | 46.18 | <.0001 | 56.16 | <.0001 |
| DVLK | PAF | 6 | 31.12 | .0526 | 10.94 | <.0001 |
| FNWZ | SAC | 2 | 3.54 | .0598 | 4.74 | .0294 |
| FXBM | SAC | 3 | 50.33 | <.0001 | 42.54 | <.0001 |
| GJKZ | SAC | 2 | 16.67 | <.0001 | 19.94 | <.0001 |
| JFSD | SAC | 2 | 4.90 | .0268 | 10.97 | .0009 |
| JREZ | SAC | 2 | 3.47 | .0625 | 5.26 | .0218 |
| LWRC | SAC | 2 | 4.01 | .0451 | 5.94 | .0148 |
| LXEZ | PAF | 2 | 20.54 | <.0001 | 0.88 | .3492 |
| NRCH | SAC | 2 | 12.77 | .0004 | 16.90 | <.0001 |
| PCZP | SAC | 3 | 4.47 | .1072 | 4.90 | .0862 |
| PLXL | SAC | 2 | 10.42 | .0012 | 13.67 | .0002 |
| PQWY | MAC | 2 | 16.79 | <.0001 | 18.73 | <.0001 |
| QJVF | SAC | 2 | 5.13 | .0235 | 8.23 | .0041 |
| SZDT | SAC | 2 | 13.84 | .0002 | 0.00 | 1.0000 |
| THWA | SAC | 2 | 26.77 | <.0001 | 2.89 | .0890 |
| UHHZ | SAC | 2 | 1.83 | .1763 | 3.41 | .0646 |
| VLSB | TAC | 3 | 89.73 | <.0001 | 57.46 | <.0001 |
| XBGX | AFE | 2 | 30.09 | <.0001 | 0.08 | .7792 |
| XDAT | MAC | 2 | 0.23 | .6342 | 11.52 | .0007 |
| ZJXD | SAC | 2 | 6.81 | .0091 | 8.44 | .0037 |

Table 7: Results of the Chi-Square Tests

The value of p given in each case is the probability of obtaining a $\chi^2$ value as large as that shown if the hypothesis were in fact true. (A p value less than .05 is usually considered sufficient grounds for rejecting an hypothesis.) From the $\chi^2$ statistics and associated p-values given above, it can be seen that for this CMD/GELOC the flying operations allocation and the crew allocation give similar results. However, the results of the PEC allocation differ significantly from the others.

The primary assumption motivating this analysis is that the PEC allocation is close to "ground truth." Therefore, if one of the other allocations is close to the PEC allocation, it should be considered an acceptable substitute. Of course, it would also be easier to implement than the PEC approach. Table 7 lists the results of the chi-square tests for each of the CMD/GELOCs considered. It can be seen from the table that these results are not consistently in favor of one allocation. In some cases, the crew allocation is a better substitute for PEC allocation while in other cases, the flying operations allocation is a better substitute. In several cases, both allocations give dismal results when compared with the distribution based on PEC.

The chi-square statistics obtained for a given hypothesis for different CMD/GELOCs are statistically independent. They may therefore be combined into an overall statistic which reflects how well the particular allocation performs for all of the data. These summary statistics are given below for the two hypotheses considered in Table 7:

Crew vs. PEC: $\chi^2=418.0$, $p < .0001$

Flying Operations vs. PEC: $\chi^2=363.1$, $p < .0001$.

$$\chi^2 = \sum_i \sum_j \frac{(O_{ij}-E_i)^2}{E_i}$$

where $\chi^2$ denotes the test (chi-square) statistic,

$O_{ij}$ denotes the observed staff allocation for MD i by allocation procedure j,

and $E_i$ denotes the average allocation for MD i by the procedures being compared.

The outer summation (over i) is over all MDs at the particular CMD/GELOC while the inner summation (over j) is over the procedures being compared.

If the hypothesis being tested is true, there should be no differences, except those due to chance variation, in the observed allocations. In that case, $\chi^2$ has a chi-square distribution. For hypothesis (1) there are 2(N-1) degrees of freedom while for the other hypotheses there are (N-1) degrees of freedom, where N is the number of MDs at that CMD/GELOC. If the allocation procedures do not produce equivalent results, the value of $\chi^2$ will be large. Therefore, the hypotheses are rejected if the values of $\chi^2$ are larger than those which could reasonably be expected to occur by chance.

The values of $\chi^2$ for the four hypothesis tests performed on the data from SAC/BWKR are given below:

(1) $\chi^2$=11.5, p = .0032 (three allocations)

(2) $\chi^2$=11.3, p = .0008 (flying operations vs. PEC)

(3) $\chi^2$=1.17, p = .2796 (flying operations vs. crew)

(4) $\chi^2$=5.32, p = .0211 (crew vs. PEC).

## C. STATISTICAL ANALYSIS

As stated in the previous section, Desmatics compiled tables for 26 CMD/GELOCs which displayed the distribution of staff personnel to MDs according to the three allocation procedures considered. A statistical analysis utilizing chi-square tests was then performed on the data. The chi-square procedure is designed to test the independence of two or more factors. Applied to this data, it tests whether there are any significant differences between the distributions of staff personnel produced by the three allocation procedures. Desmatics considered four different hypotheses concerning the data:

(1) The three allocation procedures produce equivalent results.

(2) The flying operations allocation and the crew allocation produce equivalent results.

(3) The flying operations allocation and the PEC allocation produce equivalent results.

(4) The crew allocation and the PEC allocation produce equivalent results.

Hypothesis (1) was considered first. Obviously, if there is no evidence to contradict this hypothesis, there is no need to consider the other questions. However, if the first hypothesis is rejected, there is some evidence of differences between the three allocation procedures. The other three hypotheses may then be tested in order to isolate those differences.

The statistic used to test each hypothesis is:

BLYTHEVILLE AFB, AR (BWKR SAC)

Distribution of 85 staff personnel on the basis of:

| MD | Flying Ops | Crew | PEC |
|---|---|---|---|
| B52 | 44 | 51 | 65 |
| KC135 | 41 | 34 | 20 |
| | 85 | 85 | 85 |

| MDS | AVG NO. OF A/C |
|---|---|
| B52G | 12.91 |
| KC135A | 14.69 |

Table 6: Sample FY83 Data For One of the Bases Used in the Staff Allocation Study

tion of this method, consider the situation in which 110 staff personnel were to be allocated to B52s and KC135s at a CMD/GELOC. If 80 staff are in PEC 11113 (B52) and 20 are in PEC 11142 (KC135) out of the 110 total, then eight of the ten who cannot be identified by PEC with any particular MD are allocated to the B52 using a ratio of 80/100, and two are allocated to the KC135 using a ratio of 20/100.

Table 6 exhibits the data used for one of the sample CMD/GELOCs: SAC/BWKR (Blytheville AFB, AR). The FY83 WSSC History file shows that there were an average of 12.91 B52Gs and 14.19 KC135As at Blytheville in SAC. WSSC identified 220 personnel as crew for these aircraft and allocated a total of 95 command staff personnel to those MDSs on the basis of flying operations ratios. Desmatics examined the MPC detail records for this base and concluded that ten of the staff personnel identified by WSSC are not related to the SAC aircraft operations of Blytheville and should be omitted. These included personnel in PEC 11310 (Worldwide Command & Control), and in PEC 11830 (Operational Headquarters), which represent organizations at echelons deemed by CAIG to be too high for inclusion. Accordingly, these were omitted from the staff total.

The column in Table 6 headed Flying Ops shows the result of allocating the 85 SAC staff personnel at Blytheville AFB using flying operations ratios. The column headed Crew shows how many staff personnel would be assigned to each MD using crew strength ratios. The column headed PEC shows the distribution of the 85 staff based on ratios of the staff personnel in PECs 11113 (B52) and 11142 (KC135).

eighteen MDs.

Initially Desmatics intended to define the total staff strengths at these CMD/GELOCs as the sum over all MDSs as reported in the history file. However, a detailed examination of MPC data for several of the bases led to the conclusion that by using FAC as the sole criterion for staff identification, WSSC often seriously overstates the number of staff personnel. At several bases it was observed that many personnel WSSC selects in FAC 13xx are not associated directly with flying operations of the aircraft at these bases. In many instances they are in higher level organizations (e.g., Air Division) which CAIG excludes. Desmatics also found that some of these personnel are the staff of colocated missile squadrons and ground schools, which have no relationship to aircraft. Desmatics therefore adjusted the staff counts for these sample bases accordingly. More information on extraneous staff personnel is presented in Section VII.

After adjusting staff counts, Desmatics prepared a table for each CMD/GELOC with rows corresponding to the MDs at that CMD/GELOC and columns representing the three distributions of staff personnel among the MDs: (1) allocated using flying operations ratios, (2) allocated using crew strength ratios, and (3) the majority identified by PECs which have unique MD associations, with the remaining staff personnel allocated using strength ratios of those identified by PECs.

In approach (3) only a relatively small portion of the staff personnel are allocated; most are uniquely identified. Thus, this approach involves much less allocation than (1) or (2). To provide an illustra-

| GELOC | Base | CMD | No. of MDs | MDs Represented |
|---|---|---|---|---|
| AEDY | Alconbury | AFE | 2 | F5, RF4 |
| AJJY | Anderson | SAC | 2 | B52, KC135 |
| AWUB | Barksdale | SAC | 3 | B52, KC135, KC10 |
| BWKR | Blytheville | SAC | 2 | B52, KC135 |
| DDPF | Carswell | SAC | 2 | B52, KC135 |
| DESR | Castle | SAC | 2 | B52, KC135 |
| DVLK | Clark | PAF | 6 | F4, F5, F4G, CT39, MC130, T33 |
| FNWZ | Dyess | SAC | 2 | B52, KC135 |
| FXBM | Ellsworth | SAC | 2 | B52, KC135 |
| GJKZ | Fairchild | SAC | 2 | B52, KC135 |
| JFSD | Grand Forks | SAC | 2 | B52, KC135 |
| JREZ | Griffiss | SAC | 2 | B52, KC135 |
| LWRC | KI Sawyer | SAC | 2 | B52, KC135 |
| LXEZ | Kadena | PAF | 2 | F15, RF4 |
| NRCH | Loring | SAC | 2 | B52, KC135 |
| PCZP | March | SAC | 3 | B52, KC135, KC10 |
| PLXL | Mather | SAC | 2 | B52, KC135 |
| PQWY | McChord | MAC | 2 | C130, C141 |
| QJVF | Minot | SAC | 2 | B52, KC135 |
| SZDT | Pease | SAC | 2 | FB111, KC135 |
| THWA | Plattsburgh | SAC | 2 | FB111, KC135 |
| UHHZ | Robins | SAC | 2 | B52, KC135 |
| VLSB | Shaw | TAC | 3 | F16, RF4, O2, CH3 |
| XBGX | Torrejon | AFE | 2 | F16, F4 |
| XDAT | Travis | MAC | 2 | C141, C5 |
| ZJXD | Wurtsmith | SAC | 2 | B52, KC135 |

Table 5: Summary of Bases Used in Staff Allocation Study

| PEC | MD |
|---|---|
| 11113 | B52 |
| 11115 | FB111 |
| 11142 | KC135 |
| 11312 | EC135 |
| 12114 | F106 |
| 12116 | F15 |
| 27121 | A7 |
| 27128 | F4 (except F4G) |
| 27129 | F111 |
| 27130 | F15 |
| 27131 | A10 |
| 27133 | F16 |
| 27136 | F4G (Wild Weasel) |
| 27213 | RF4 |
| 27215 | TR1 |
| 27218 | F5 |
| 27222 | KC10 |
| 41115 | C130 |
| 41118 | C141 |
| 41119 | C5 |
| 41311 | C130 |

Table 4: Program Element Codes (PECs) having Unique Associations with Aircraft at the Mission-Design (MD) Level

missile crew personnel), 3280, 37xx or 4724.

## B. APPROACH TO COMPARING ALLOCATION METHODS

Desmatics observed that there are several Program Element Codes (PECs) which have unique aircraft associations at the Mission-Design (MD) level. For example, in AFR 300-4 [22] the description of PEC 11113 explicitly states that it is for B52 squadrons. Likewise PEC 11142 is for KC135s and PEC 27222 is for KC10s. Table 4 lists 21 PECs which have explicit associations with specific aircraft at the MD level.

If every MDS had one and only one PEC associated with it, in which all costs were reported in ABDS and all personnel in MPC, then no allocation would be necessary. Although this is not the case, there are enough such relationships to support a study designed to compare crew ratios with flying operations ratios as a basis for allocating staff personnel and costs to the MDS level.

The study employed FY83 MPC data and the FY83 CMD/GELOC/MDS History File. Desmatics first identified CMD/GELOCs in the MPC data which had at least two MDs with unique PEC associations. The records in the history file were then used to determine the total number of crew and staff personnel at each of these CMD/GELOCs, and to compute the flying operations and crew ratios for each MD at these CMD/GELOCs.

In all, Desmatics identified 26 CMD/GELOC combinations having at least two PEC-associated MDs. Table 5 summarizes these 26 bases and shows the commands and MDs involved. They represent five MAJCOMs and

quantified assessment of the relative merits of using crew strengths versus flying operations ratios. The method used was essentially to compare the allocations produced by each method with "ground truth" for a sample of bases. The results were ambiguous. For some bases crew strength ratios gave good results, but for other bases the best allocations were produced using flying operations ratios. However, in some instances neither method was satisfactory. As a consequence, Desmatics now recommends an alternative strategy which is described in subsection D.

The following sections describe the methods employed in this study, present the findings, and outline the conclusions and recommendations. Also included are some observations on the effect of data selection criteria on the results.

## A. WSSC STAFF SELECTION CRITERIA

WSSC identifies staff and other unit personnel (referred to hereafter as "staff") in the files obtained from E300Z on the basis of FACs (Functional Account Codes [20]). Pay costs for military personnel are determined by applying standard pay rates by grade to personnel counts. Other costs (such as materiel and civilian pay) are selected from H069R using Responsibility Center/Cost Center (RC/CC) codes [24] which correspond to the FACs of the personnel.

In identifying staff personnel, WSSC first identifies crew personnel and sets them aside. The remaining personnel are then identified as staff if they have FACs 13xx (except 1311), 31xx (except certain SAC

## V. ALLOCATION OF COMMAND STAFF AND OTHER UNIT PERSONNEL

Part of the cost for operating and maintaining aircraft is the cost of command staff and other personnel necessary for the day-to-day operation of the units to which aircraft are assigned. Included in WSSC are the pay and allowances and other direct expenses for personnel at squadron level performing such functions as unit command, administration, flying supervision, operations control, planning, scheduling, flight safety and aircrew quality control. Also included are certain staff and administrative functions at group and wing level.

The concept for deriving command staff and other unit personnel costs within WSSC calls for the identification of costs from H069R, the Accounting and Budget Distribution System (ABDS), and personnel strengths from E300Z, the Advanced Personnel Data System (MPC), at the CMD/GELOC level. Allocation to the MDS level is accomplished using flying operations ratios.

When Desmatics first evaluated this algorithm, the question arose as to whether flying operations ratios constitute the best basis for allocation. Consideration was given to the alternative of allocation in proportion to crew strengths. Desmatics supported the concept of crew strengths as the basis for command staff allocation in Volume III [ 8 ], on the grounds that the level of command staff activity required for an MDS intuitively should be more related to the number of crew personnel than to the number of aircraft and the amount of flying.

Desmatics recently reexamined this problem in order to make a

craft. This was used to assess the allocation of staff personnel to aircraft using flying operations ratios and crew strength ratios. Since it was found that flying operations ratios and crew strength ratios fail to provide satisfactory allocations, Desmatics recommends using PECs to match aircraft records from AVISURS with staff personnel records from MPC.

## VI. INDIRECT PERSONNEL SUPPORT

The WSSC system has been evolving continuously since its inception. As Desmatics has gathered additional information about WSSC, as well as the C-E system, a number of additional recommendations were developed in the area of indirect personnel support. These recommendations are put forth here. The first one deals with the separate visibility of indirect personnel costs for unit mission personnel. The remaining recommendations (retirement, dependents' education, civilian PCS, and temporary duty travel) deal with costs which can be considered indirect personnel support. Currently, these costs are not included in the WSSC system, or are not given separate visibility. Included in the discussion is a sample WSSC output, in the USAF Detail format, which incorporates the changes recommended in this section.

### A. VISIBILITY OF INDIRECT PERSONNEL COSTS

WSSC develops indirect personnel costs (medical care and PCS) for unit mission and installation support personnel. On the WSSC output products, costs for these groups of personnel are combined. The CAIG format displays these costs under the subheading of Indirect Personnel Support. On the USAF Detail format each cost is a separate category. Desmatics recommends a subheading of Indirect Personnel Support be added to the USAF Detail format as shown in Figure 3. This would clarify the report by grouping similar costs together as was done with

| Description | Total | Materiel | Contract | Other | Personnel Benefits | ----PAY & ALLOWANCES----- Officer | Airmen | Civilian |
|---|---|---|---|---|---|---|---|---|
| Installation Support | | | | | xxx | | | |
| Real Property Maintenance | | | | | xx | | | |
| Communications | | | | | xx | | | |
| Base Operating Support | | | | | xx | | | |
| Indirect Personnel Support | | | | | xxx | | | |
| Medical Care | | | | | xx | | | |
| PCS | | | | | xx | | | |
| Officer | | | | | x | | | |
| Airmen | | | | | x | | | |
| Civilians | | | | | x | | | |
| TDY | | | | | xx | | | |
| Retirement | | | | | xx | | | |
| Officer | | | | | x | | | |
| Airmen | | | | | x | | | |
| Civilians | | | | | x | | | |
| Other Civ Benefits (medical, insurance, etc.) | | | | | xx | | | |
| Dependents' Education | | | | | xx | | | |

Figure 3: Section of USAF Detail Report Incorporating Desmatics' Recommendations

other similar costs such as Installation Support.

Under this new subheading, Desmatics recommends that only indirect costs of unit mission personnel be displayed. This would make the WSSC output more useful; the user would have a better indication of the indirect personnel costs incurred by the mission personnel of an MDS. These types of costs for BOS, RPM and COM personnel are more properly included with other Installation Support costs as they are not directly related to an aircraft's mission.

In order to accomplish this, medical care and PCS costs could continue to be computed as they are now. The only difference would be that costs for installation support personnel (PECs xxx94, xxx95, 33112, 35114, and xxx96), once computed, would be added to Installation Support instead of Indirect Personnel Support. Any additional indirect personnel costs (i.e., those discussed in the following sections) should be treated in a similar manner.

## B. RETIREMENT BENEFITS

The WSSC system currently does not account for the cost of retirement benefits to military personnel, and includes only a portion of civilian benefits. Because these are significant expenses and in order to comply with CAIG guidelines, these costs should be included. Although the CAIG does not specifically mention retirement costs, it defines relevant costs as "those that can be affected by OSD and Military Department actions during the DSARC process. The objective is to specify

all relevant O&S costs to the government regardless of how such costs are funded." [3]

Military retirement costs are not funded by the Air Force, and cannot be obtained directly. However, the USAF Cost and Planning Factors (AFR 173-13), identifies the cost of retirement per military person as an additional 33% above the pay and allowances in the pay tables [25]. Desmatics recommends this factor be used to develop retirement costs in the WSSC system. These costs can be computed at the same time as pay and allowances by multiplying personnel costs by the current retirement factor.

Only the funded portion of retirement costs for civilians is currently included in WSSC, but it is not given separate visibility. Both funded and unfunded civilian benefits should be included in the WSSC system. Desmatics recommends the following method for costing retirement and other benefits of civilian mission personnel:

1) Remove costs with EEIC 393 (funded civilian benefits) [19] from the pay and allowances of mission personnel.

2) Multiply civilian base pay (EEIC 392) by the retirement and benefit factors from AFR 173-13, 29.5% and 6.5% respectively [25]. These factors include both funded and unfunded costs.

Retirement and other benefits also should be included in WSSC for civilian installation support personnel. The funded portion of these benefits (EEIC 393) is currently included in Installation Support and allocated correctly. (However, as can be seen in Figure 3, Desmatics recommends that these costs be given visibility.) To obtain the unfunded portion of these benefits, the funded benefits (16.39% for 1984

according to AFR 173-13) must be subtracted from the total benefits (29.5% retirement + 6.9% other benefits) [25]. The remaining 20.01% represents unfunded benefits. Desmatics recommends the following method for including these costs in installation support:

1) Sum costs with PECs xxx94, xxx95, xxx96, 33112 or 35114 and EEIC 392 (civilian base pay) [19] within GELOC.

2) Multiply this sum by the unfunded portion of benefits (20.01%).

3) Add this product to the EEIC 393 costs for those PECs in that GELOC.

Since retirement costs for military and civilian personnel are directly related to the number and pay grade of personnel associated with a particular mission, they should be allocated to the MDS level in the same manner as pay and allowances. For information on how personnel are selected and allocated, refer to Volume III for mission personnel [8], and Volume II for installation support personnel [7].

On the WSSC output, the cost of retirement benefits for unit mission personnel should be displayed separately under the subheading of Indirect Personnel Support. Retirement costs for installation support personnel should be added to the total Installation Support cost. Figure 3 shows these changes to the USAF detail format of the WSSC output.

## C. DEPENDENTS' EDUCATION

Another personnel benefit currently not costed by the WSSC system is dependents' education. It can be considered a relevant cost according

to the CAIG definition, and also is a significant personnel expense. For example, the Department of Defense estimates the average annual cost of educating dependents overseas is $1500 per dependent [4]. By including the costs of dependents' education, WSSC would present a more accurate picture of the indirect personnel costs associated with an MDS.

Overseas schools for dependents are usually located on base, and are funded by the Department of Defense. Educational agencies in the United States may obtain federal assistance for school construction, operation and maintenance when federal activities (e.g., Air Force installations) cause increases in school membership [27]. These expenses may be paid by the Air Force base, but are funded by the U.S. Office of Elementary and Secondary Education within the Department of Education [2,28].

Dependents' education costs are not available directly, but costs could be allocated by developing an average cost factor similar to the medical care factor. Since costs are related to personnel, they may also be allocated to the MDS level in the same manner as pay and allowances (see Volumes II [7] and III [8]). Costs for unit mission personnel should be displayed separately under the heading of Indirect Personnel Support. Dependents' education costs for installation support personnel should be added to Installation Support. See Figure 3.

As mentioned previously, the Department of Defense has developed a factor for education of civilian and military dependent children overseas [4]. Desmatics recommends the Office of VAMOSC contact the U.S. Office of Elementary and Secondary Education to determine the feasibility

of developing an average cost per employee for dependents' education in the United States.

To avoid double-costing, records with PEC xxx96 and Responsibility Center/Cost Center (RC/CC) xx494x (dependent education) should be removed from the WSSC system. This RC/CC contains some dependents' education expenses in the United States, but is not inclusive.

## D. CIVILIAN PCS

In Volume VI Desmatics recommended PCS costs for civilian personnel be developed based on actual PCS moves. (Currently PCS costs for civilians are included in WSSC with Base Operating Support and allocated on the basis of flying operations data.) The Office of VAMOSC did not concur with this recommendation, stating that there are insufficient civilian PCS moves to justify developing these costs. Since that time Desmatics has learned that the Defense Communications Agency (DCA) has already developed average PCS cost factors for civilians [4].

Desmatics recommends the Office of VAMOSC investigate the possibility of using these factors to allocate civilian PCS costs in the same manner as military PCS costs (See Volume VI [32]). To avoid double-costing, records with RC/CCs of xx8101 (Civilian PCS) would need to be removed.

PCS costs for mission personnel should be separately displayed in Indirect Personnel Support; these costs for installation support personnel should be added to Installation Support. By displaying PCS costs

of civilian personnel along with those of military personnel, WSSC will more closely conform with CAIG guidelines. The proposed method is also more direct since costs would be allocated on the basis of actual PCS moves, rather than flying operations ratios.

## E. TEMPORARY DUTY TRAVEL

Temporary Duty (TDY) travel costs are defined as the expenses incurred to move an individual or individuals to a different duty station for a specific period of time (not to exceed 89 days), followed by a return to the original or new permanent duty station [18]. According to CAIG guidelines TDY costs should be included under Indirect Personnel Support. The WSSC system correctly categorizes them this way on the CAIG format output, but includes them in "other" under Unit Mission Personnel on the AF Detail format. Desmatics recommends these costs, which can be identified by EEICs of 40x, be removed from Unit Mission Personnel and displayed separately under Indirect Personnel Support on the AF detail format. TDY costs for Installation Support personnel are already included in Installation Support, but should be displayed along with other personnel benefits in this category (See Figure 3).

## F. SAMPLE WSSC OUTPUT

The sample output in Figure 3 suggests how the changes recommended

in this section may be incorporated into the USAF Detail Operating and Support Cost Report. This sample includes only sections relevant to these changes. The major differences in the report format are the addition of another column entitled "Personnel Benefits," and a subheading entitled "Indirect Personnel Support."

For the Installation Support subheading the following groups of costs for installation support personnel should be included in the "Personnel Benefits" column.

1) Medical costs computed using the medical care factor.

2) PCS costs computed using average costs per Type-PCS move.

3) Unfunded retirement costs and other benefits computed using the factors in AFR 173-13.

4) Funded civilian retirement and benefits - EEIC 393 in the ASO extract.

5) TDY costs - EEICs 40x in the ASO extract.

6) Dependents education costs computed by average cost factors.

These costs will be broken out separately for unit mission personnel as shown, under Indirect Personnel Support, on the AF detail format.

## VII. SOME DATA-RELATED TOPICS

This section examines topics dealing with input data to the WSSC system and how that data is treated in the algorithms and processing of the system. A number of problem areas are identified and discussed. Specific solutions are recommended or, in those cases where this is infeasible, approaches that should establish required solutions are described.

### A. MATCHING PERSONNEL AND COSTS

During its investigation into the various topics covered in this volume, Desmatics has encountered situations which suggest that there may be problems with the approach WSSC uses to allocate costs. The main problem arises from the fact that costs and personnel are aggregated to two different levels. Personnel records from MPC contain a GELOC, which identifies the location at which a person is stationed. Cost records from H069R, however, are identified by OAC/OBAN, which is a code used to identify a particular MAJCOM budget account number.

In order to correctly allocate costs, it is necessary to match personnel with the costs attributable to them. The WSSC system attempts to do this by building the OAC/OBAN-GELOC table, which is based on data gathered from the major commands. There are shortcomings with this table, however. There does not seem to be a one-to-one correspondence between OAC/OBANs and GELOCs.

It is impossible for Desmatics to determine the extent of the problem

based on the available WSSC data, but the C-E system (D160A) collects data which indicates the OAC/OBAN associated with a particular C-E organization. An examination of the FY82 C-E data showed that several C-E organizations, each at a different GELOC, shared an OAC/OBAN. This is a common occurrence in the C-E data. If, in the WSSC system, there is not a one-to-one relationship between OAC/OBANs and GELOCs, a basic implicit assumption of many WSSC algorithms is violated. Therefore, the WSSC system is incorrectly allocating costs in some cases since it assigns only one GELOC to an OAC/OBAN, even though the OAC/OBAN may span several GELOCs. WSSC uses the people at that one GELOC as the basis for allocation, even though the costs could have come from other GELOCs. This would, for example, overstate the installation support costs for that GELOC, and understate them for any other GELOCs involved in the OAC/OBAN.

In addition, there is evidence that the OAC/OBAN-GELOC table may not be comprehensive. For instance, for FY81-FY83 WSSC did not have an OBAN for Systems Command at Wright-Patterson AFB. Since people from this command comprise over half the population at that base, it seems likely that some costs were generated by them. By not having such an OBAN in the table, any costs reported against a Systems Command OBAN at Wright-Patterson were lost.

In the same vein, while examining below depot maintenance cost data Desmatics found that some materiel costs are missing for MDSs at GELOCs where the owning command has no entry in the OAC/OBAN-GELOC table. Maintenance materiel costs are selected from H069R by OAC/OBAN

and multiplied by the maintenance-manhour ratio for that CMD/GELOC/MDS. A table relates OAC/OBAN to CMD/GELOC, but Desmatics has found a number of CMD/GELOCs which have no entries in this table. These CMD/GELOCs have possessed aircraft in the FY83 WSSC AF History File, however. Consequently, materiel and other costs from H069R are being lost for MDSs possessed by these CMD/GELOCs. A list of those found in FY83 WSSC data is in Table 8. OAC/OBANs for these CMD/GELOCs should be added to the OAC/OBAN table, to ensure complete costing.

The incompleteness of the OAC/OBAN-GELOC table leads to other problems as well. Because of the way WSSC processing builds the MDS history file, personnel costs and strengths from the summed personnel strengths file are also being lost for CMD/GELOCs which possess MDSs, but have no OAC/OBANs in the table. For example, the ASO consolidated operations file (from H069R data) and the MPC summed operations personnel strengths file are merged in order to build part of the history file. Records which do not match are not carried forward. This understates personnel strengths and military pay, as well as the costs which are obtained from H069R, for those CMD/GELOCs with no OAC/OBANs. For example, for FY83 at Suwon AB, Korea, the summed personnel strengths file shows 33 command staff and 22 crew in support of PAF A-10s. The WSSC history file, however, shows zeroes for operations personnel strengths and dollars. This is because an OAC/OBAN for PAF at Suwon AB does not appear in the OAC/OBAN table.

In examining the history file for FY83, Desmatics also found personnel strengths of zero for a number of CMD/GELOCs which have

| COMMAND | GELOC | LOCATION | MDSs |
|---|---|---|---|
| MAC | FSPM | Edwards AFB, CA | UH001N |
| MAC | KZPC | Hong Kong International Airport | C130E, HC130P |
| MAC | MBCV | Keflavik, Iceland | HH003E |
| MAC | NZAS | Malmstrom AFB, MT | TH001F, UH001F |
| MAC | QYZH | Mt. Home AFB, ID | UH001N |
| MAC | SXHT | Patrick AFB, FL | CH003E |
| MAC | WKKX | Stuttgart Airfield, Germany | CT039A |
| MAC | XUMU | Vandenberg AFB, CA | UH001N |
| MAC | ZBVU | Winchester, VA | UH001N |
| MAC | ZFKN | RAF Woodbridge, UK | HH053C, HC130H, HC130N, HC130P |
| MAC | ZRZF | Zaragoza AB, Spain | UH001N |
| PAF | CZGR | Canberra Airport, Australia | C012A |
| PAF | WNHQ | Suwon AB, Korea | A10A |
| PAF | WPZQ | Taegu AB, Korea | F004E |
| PAF | YVEW | Wheeler AFB, HI | 0002A, OV010A |
| SAC | AQDS | Hellenikon AB, Greece | RC135U, RC135V, RC135W |
| SAC | ZRZF | Zaragoza AB, Spain | KC135A |

Table 8: CMD/GELOCs with Possessed Aircraft in the FY83 WSSC History File, but with no entry in the OAC/OBAN table.

and allocated in the WSSC system. As a result the WSSC user is not getting the best 'nformation possible. In order to remedy this, an investigation needs to be made into how MDSs are recorded in AVISURS, and also how personnel are recorded in MPC. With this information in hand a better allocation procedure may then be devised.

## D. WEATHER SQUADRONS

At this time the WSSC system is not capturing the costs of weather squadrons and allocating them to aircraft. The Office of VAMOSC has indicated it is proper to include all weather squadron operations costs (RC/CCs of xx34xx) and personnel (FAC 34xx) in WSSC. Since it would be difficult to estimate the portion of these costs which is not in support of the Air Force flying mission, Desmatics agrees with the Office of VAMOSC contention that the full burden of these costs be placed on Air Force aircraft.

It is reasonable to assume that an aircraft which flies more often will consume more weather information services. Therefore, these costs should be allocated to aircraft using flying hours or sorties as the basis for allocation. However, it is important that all aircraft be considered in allocating these costs, not just those in the relevant commands. Otherwise, costs will be overallocated to aircraft included in the WSSC system. Once allocated to the MDS these costs should be displayed along with other Unit Operations costs on the WSSC output.

activities, but are treated as command staff of MDSs (see Section VII B). However, there may still be a number of instances when aircraft are possessed by one GELOC, but have personnel assigned at another GELOC. For example, there are A-10s based in England which operate from forward positions in Germany.

This suggests that all personnel properly identified by FAC or PEC as Unit Operations Personnel should be costed by the WSSC system even though there are no MDSs at their CMD/GELOC. In order to implement this, an alternative to the AVISURS system must be used as a means of identifying these personnel to MDSs. One possible approach is the use of PECs to identify personnel related to a particular MD. An investigation needs to be undertaken to determine the feasibility and optimal implementation of this approach.

Security personnel and their associated costs are also being lost or misallocated for WTD bases. Security costs are allocated, on the basis of possessed hours, to all the MDSs requiring security at that GELOC, regardless of command. For FY83 Aviano AB and Incirlik AB had no possessed aircraft, but Aviano had 173 security personnel and Incirlik had 151 security personnel. The costs for these people were not allocated to any MDSs. At Zaragoza in FY83, MAC possessed three UH001N helicopters and SAC had three KC135As. All security costs for this base were allocated to these MDSs, although some of the cost probably should be charged against the AFE F-4s on WTD.

This example using WTD bases points out that there are problems in the way personnel and their associated costs are currently selected

ever, the WSSC system identified command/crew personnel at these bases. Desmatics examined the MPC data for FY83 to determine if, in fact, these personnel are aircraft related, and therefore should be costed by WSSC.

These personnel at Incirlik and Aviano are members of the 39th and 40th Tactical Air Training Groups respectively. The PECs of a large number of these people further identify them as members of F-4 Squadrons or F-16 Squadrons, even though in the AVISURS system these bases do not possess F-4s or F-16s. At Zaragoza the WSSC personnel lost to the system are members of the 406th Tactical Fighter Training Wing, the 86th Tactical Fighter Group, and the 526th and 512th Tactical Fighter Squadrons. The PECs of these personnel also identify them with F-4 Squadrons. The 86th Tactical Fighter Group and the 526th and 512th Tactical Fighter Squadrons appear to be units on WTD, as the PAS (Personnel Accounting Symbol) directory identifies the GELOC of these organizations as Ramstein AB, Germany. If the PEC codes are used properly, all these personnel would appear to be aircraft related, yet they are not costed by WSSC.

This problem does not seem to be confined to these WTD bases. A large number of people, who are identified by WSSC in the summed MPC strengths file as command/crew/other, are not being costed. This is because there are no MDSs in the AVISURS system at their CMD/GELOCs. Some of these people should legitimately be excluded from WSSC. Desmatics has found personnel who are not involved in aircraft related

C. WEAPONS TRAINING DEPLOYMENT

Aircraft and personnel from bases in England and Germany are deployed periodically to bases in Spain (Zaragoza AB), Italy (Aviano AB), and Turkey (Incirlik AB). The Office of VAMOSC has indicated that some costs may be missing from the WSSC system for these Weapons Training Deployment (WTD) Bases. The reason for this is that the aircraft are still recorded in the AVISURS system as being assigned to and possessed by their home bases (GELOCs) while deployed.

Desmatics has examined and evaluated data for these bases in light of the various WSSC allocation algorithms. The algorithms found to be impacted are those for Unit Operations Personnel, and the algorithms which use operations personnel strengths. Discussion will be restricted to Unit Operations Personnel, however, since other algorithms affected by personnel strengths will be correct if the appropriate personnel are costed.

Unit Mission Personnel are selected on the basis of FAC and classified as command, crew, security, maintenance or other. Maintenance personnel are allocated as discussed above. Command, crew, security and other personnel are allocated on the basis of flying operations ratios.

Command, crew, and other personnel in a CMD/GELOC are allocated to the MDSs in that CMD/GELOC. If there are no MDSs possessed there, these personnel costs are lost to the WSSC system. U.S. Air Forces in Europe (AFE) possess no MDSs at any of the three WTD bases. How-

Some of the Life Support Personnel identified by FAC 4724 as Unit Staff appear to be performing Chemical/Biological Defense duties in support of the entire base rather than Life Support duties in support of unit aircraft. The AFSC description for personnel in FAC 4724 indicates that both types of activity are included.

At one base in Desmatics' sample (Anderson AFB, Guam) some of the FAC 4724 personnel were reported under PEC 11113 (B52) and some under PEC 11142 (KC135). This, incidentally provides a way for WSSC to identify them with MDs. However, some FAC 4724 personnel at Guam were reported in PEC 11896W, which the manual describes as "CW Def Trg." This suggests that these individuals should be treated as BOS rather than unit staff, on the grounds that they provide basewide support in chemical warfare defense training rather than support solely to the aircraft mission.

In summary, Desmatics contends that PECs provide a method for identifying high echelon and other personnel which should not be included in the WSSC reports. PECs can be used not only to exclude personnel from MPC records, but also costs from ABDS files. The findings enumerated here are only indicative of the types of extraneous personnel and costs currently included by WSSC, and is not an exhaustive list. The Office of VAMOSC should examine this problem in further detail.

| PEC | Description |
|---|---|
| 11310 | SAC Worldwide Military Command & Control System ADP |
| 28019 | Tactical Cryptologic Activity |
| 31011 | Cryptologic Activity |
| 31315 | Foreign Technology Division |
| 31317 | Foreign Technology Division |
| 35111 | Air Weather Service |
| 35160 | Defense Meteorological Satellite |
| 35165 | Navstar Global Positioning System |
| 51411 | Air Force Reserve |
| 51421 | Air National Guard |

Table 10. PECs Found in Sample of MPC Data For Personnel not Relevant to WSSC Command Staff

Technical Training, 3760-Comptroller Technical Training, 3796-Supply Procedure Training, and 3797-Transportation Training. Desmatics recommends that the Office of VAMOSC review the FACs in the 37xx series to determine which are aircraft related, and modify the personnel selection logic to exclude all irrelevant FACs of this series.

Desmatics also identified other, smaller groups of personnel who do not appear to be directly associated with particular aircraft at the CMD/GELOC/MDS level, yet WSSC treats them as staff based on FAC. Some of the PECs found by Desmatics in its sample are shown in Table 10.

The PECs listed in Table 10 are those which were encountered in a small sample taken from the FY83 MPC file, and are not exhaustive. Desmatics recommends that the Office of VAMOSC examine the entire file to build a table of PECs to be excluded from WSSC.

As indicated earlier, WSSC accepts FAC 31xx personnel but excludes certain FAC 3130 and 3140 personnel in SAC who represent ground launched missile organizations. Desmatics found that over 200 personnel in PEC 11213 (Minuteman missile) at Ellsworth AFB, Grand Forks AFB and Minot AFB were treated by WSSC as aircraft staff because they were in staff FACs not specifically identified by WSSC for exclusion. Desmatics recommends that ground launched missile personnel be excluded by dropping all PEC 11212 (Titan), PEC 27314 (Ground Launched Cruise Missile) and PEC 11213 (Minuteman) records.

Desmatics has also determined that some personnel are being classified as Unit Staff when they should be considered Base Operating Support.

PEC 11830 and xxx98 personnel and their associated costs. FAC 1356, currently included by WSSC as staff, is restricted to Numbered Air Force level and above and thus should also be excluded.

High level headquarters colocated with flying squadrons is not the only situation which causes WSSC to overstate the number of unit staff personnel. Desmatics looked in the FY83 WSSC History file and picked out a few bases which appeared to have disproportionately large numbers of command staff relative to crew. One of these was Sheppard AFB, TX, which not only has a large ATC undergraduate pilot training (UPT) activity, but also provides resident training in aircraft maintenance, civil engineering, communications, missile, comptroller, transportation and instructor training.

WSSC, based on FAC, identified 1381 staff personnel and allocated them in FY83 to the T37 and T38 aircraft associated with UPT activity at Sheppard. Desmatics looked at the detailed MPC records for Sheppard and found that 1000 of these personnel were in PEC 84731 (General Skills Training). The description in AFR 300-4 for PEC 84731 indicates that flight training is specifically excluded, and while training in aircraft maintenance may be included, the majority of activities seem to fall outside the area of aircraft operations and support. Desmatics therefore recommends that the Office of VAMOSC exclude PEC 84731.

The FACs for the majority of Sheppard's PEC 84731 personnel indicate quite clearly that they are not supporting the T37 and T38 aircraft at that base. These FACs include: 3723-Missile Maintenance Training, 3748-Telephone/Teletype Communications Training, 3750-Civil Engineering

has determined that it is infeasible for WSSC to use PAS codes to identify those personnel groups which should be excluded. However, Desmatics believes that Program Element Codes (PEC) can be used to perform this function.

Most of the higher echelon personnel and the associated costs which WSSC currently fails to exclude are in the Command Staff and Other Unit Personnel subcategories of Unit Operations. WSSC identifies personnel in these categories by Functional Account Code (FAC), accepting FACs 13xx (except 1311), 31xx (except certain SAC 3130 and 3140), 3280, 37xx and 4724. A detailed examination of a large sample of FY83 MPC data within these FACs revealed that a significant number of these personnel should not be included in Unit Operations.

Bases which include the headquarters for Major Commands, Numbered Air Forces or Air Divisions invariably contain sizable groups of personnel which WSSC, based on FAC, treats as Unit Operations, but which on the basis of PEC are in CAIG-excluded echelons. Desmatics has determined that PEC xxx98 identifies Management Headquarters at the Major Command, Division or Numbered Air Force level, while PEC 11830 covers Operations Headquarters at the Air Division level. Within a sample of FY83 data from 27 bases Desmatics found almost 750 Management Headquarters (450 at Langley alone) and 80 Operational Headquarters personnel whom WSSC, based on FAC, treated as Unit Command. In actuality, these PEC xxx98 personnel were in MAJCOM headquarters or the headquarters of five Numbered Air Forces, while the PEC 11830 personnel were in Air Division organizations. Desmatics recommends that WSSC exclude all

The combined effect of the problems mentioned in this section on the accuracy of allocation for any particular base is unknown. Desmatics recommends that the Office of VAMOSC conduct an in-depth study of the input data systems H069R and E300Z and their interrelationship within the WSSC system to determine the extent of these problems and their effects on the WSSC data and cost allocation algorithms. Such a study should be able to produce the necessary methodology for matching personnel and costs appropriately.

## B. IDENTIFICATION AND REMOVAL OF EXTRANEOUS COSTS

In Volume III, Desmatics recommended that to be in conformance with CAIG guidelines, WSSC should exclude costs for personnel "assigned to operating headquarters and staffs at and above the level of ... Air Force Air Division ..." [3]. Desmatics suggested that costs of this sort, which WSSC gets from the ABDS system, could be identified using the Responsibility Center (RC) portion of the Responsibility Center/ Cost Center (RC/CC) codes. However, personnel costs, which WSSC calculates based on strength data obtained from MPC, cannot be identified in a like manner. It was suggested also that Personnel Accounting Symbol (PAS) codes might provide the means for identifying higher echelon personnel.

Desmatics has since given further consideration to the identification of higher echelon and other costs which WSSC should omit, and

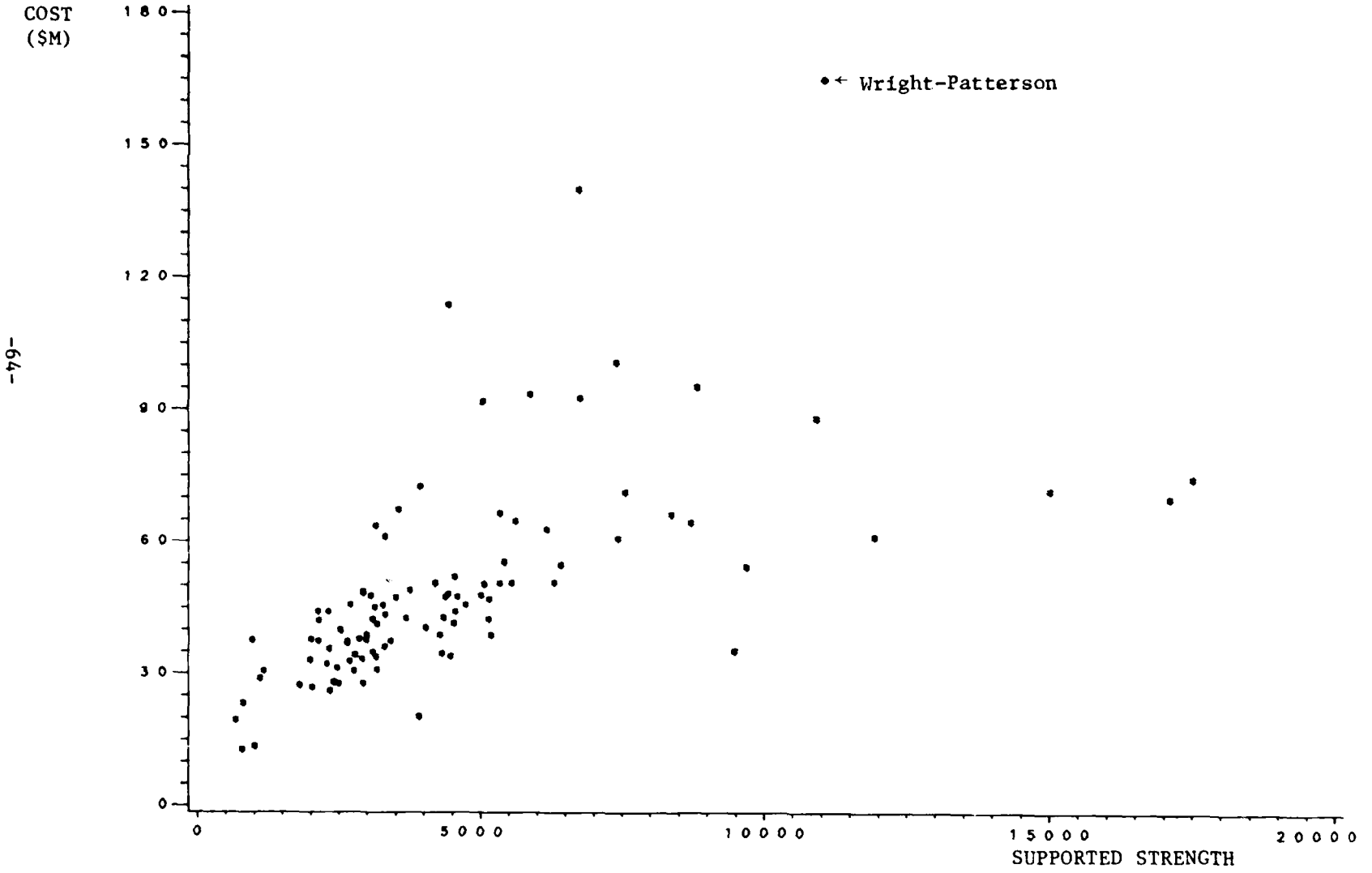


Figure 4: FY83 Installation Support Costs for Relevant Bases

supported population basis, those bases which appear to have particularly high or low costs per supported person can be detected. Figure 4 provides such a plot for FY83. From the plot, Wright-Patterson appears to have much higher costs per supported person than the rest of the bases, and was analyzed further by Desmatics. An examination of the AFR 300-4 [21] data element GE-611 (a list of all GELOCs) indicated an additional GELOC of ZHTP at Wright-Patterson for Systems Command. When this GELOC was searched for in the WSSC MPC Extract file, nearly 12,000 additional people were discovered, thereby doubling the population which WSSC uses. It is not known to what extent this multiple-GELOC problem affects other bases.

It should be noted that this problem is not restricted to situations in which the physical confines of a base are divided into several GELOCs. The same problem of achieving the correct supported personnel figure occurs when a base provides installation support services for off-base organizations and facilities, which have their own distinct GELOCs. If these people receive support from a particular base, they must be added to the population counts for that base in order to allocate correctly. The WSSC system does not do this, which overallocates installation support costs to the aircraft at the base providing support.

This situation also impacts on the BOS/WSSC factor, used to determine the portion of an installation support cost attributable to WSSC. Incorrect counts will allocate an incorrect portion of these costs to WSSC for allocation to the MDSs.

| COMMAND | GELOC | LOCATION | OAC/OBANs |
|---|---|---|---|
| MAC | AWUB | Barksdale AFB, LA | 65DF |
| MAC | FBNV | Davis Monthan AFB, AZ | 65EK |
| MAC | FXBM | Ellsworth AFB, SD | 65DM |
| MAC | JFSD | Grand Forks AFB, ND | 65DL |
| MAC | KWRD | Holloman AFB, NM | 65WC |
| MAC | PNQS | Maxwell AFB, AL | 65DY, 65ED |
| MAC | PRQE | McConnell AFB, KS | 65DV, 65ER |
| MAC | QJVF | Minot AFB, ND | 65DP |
| MAC | TDKA | Peterson AFB, CO | 65UE, 65WA, 65WW |
| MAC | THWA | Plattsburgh AFB, NY | 65DS |
| MAC | TYMX | Randolph AFB, TX | 65DJ |
| MAC | VLSB | Shaw AFB, SC | 65EB |
| MAC | XLWU | Tyndall AFB, FL | 65EG, 65UB |
| MAC | YWHG | Whiteman AFB, MO | 65DT, 65ES, 65NQ |

Table 9: CMD/GELOCs Which May Have Invalid OAC/OBANs (Personnel and Operations Costs for these CMD/GELOCs Are Not in the History File)

entries in the OAC/OBAN-GELOC table and personnel in the MPC summed personnel strengths file. A list of these is in Table 9. As can be seen from the table all are in the MAC command. Desmatics found there are no operations costs in the ASO extract for any of these CMD/GELOCs. All but two of the bases had no costs whatsoever (installation support, maintenance, etc.). This suggests either the OAC/OBANs given in the table are incorrect or the costs for these CMD/GELOCs may be in RC/CCs and PECs not selected by the VAMOH preprocessor for inclusion in the ASO extract.

In addition to problems related to cost data, there are also problems associated with personnel data. In the WSSC system, once cost records have been assigned a GELOC via the OAC/OBAN-GELOC table, personnel records from MPC with that GELOC are selected and are used as the basis for allocation.

For installation support cost allocation, Desmatics believes that this leads to an understatement of the actual number of personnel supported by a base. This is because many bases, in fact, have two or more GELOCs associated with them, whereas WSSC only considers one GELOC per base. Consider, once again, Wright-Patterson AFB. In the WSSC system, the GELOC for Wright-Patterson is given as ZHTV. Cost records from H069R are given this GELOC by WSSC. WSSC also totals the MPC records with a GELOC of ZHTV to use in the allocation of installation support costs. When these records are totalled, WSSC arrives at a population of nearly 12,000 people at that base.

When all bases are plotted on an installation support cost vs.

## E. ADDITIONAL CREW PERSONNEL

In the course of conducting its study, Desmatics noted that there are flying personnel in FAC 13xx whom WSSC should treat as crew. The majority of FAC 13xx flying personnel are instructors or evaluators, but some are specifically identified as aircrew and should be so treated. The WSSC system selects crew from FACs 31xx and 37xx. Appropriate personnel with FACs 13xx should also be included.

Enlisted aircrew personnel can be identified by an AFSC prefix of A or blank. Officer and airmen flying personnel in FAC 13xx having AFSC prefixes of K are instructors, while those with AFSC prefixes of M are examiners or evaluators [23]. Officer flying personnel in FAC 13xx without AFSC M or K prefixes can be considered to be crew. It is not clear whether or not flying personnel in FAC 13xx who are instructors or evaluators should be considered staff or crew. The Office of VAMOSC should investigate this matter and make a specific determination.

## F. BELOW DEPOT MAINTENANCE

Below Depot Maintenance costs are allocated on the basis of maintenance man-hours. At any given CMD/GELOC costs are allocated by the ratio of maintenance hours for a CMD/GELOC/MDS to the total maintenance hours for the CMD/GELOC. Any maintenance performed by a maintenance organization at a CMD/GELOC on an MDS not assigned to or possessed by

that CMD/GELOC is treated as "transient aircraft" maintenance. This data is not visible at the CMD/GELOC/MDS level as the WSSC system changes the GELOC for these aircraft to "ZZZZ." Desmatics has found no apparent reason for this, and suggests the Office of VAMOSC retain the GELOCs so it will be clear which bases perform maintenance on transient aircraft. Currently these maintenance costs are carried up to the CMD/MDS level on WSSC output products.

## G. DLH INACCURACY EFFECTS

The allocation of below depot maintenance labor costs is based on direct labor hours (DLH), which WSSC obtains from the D056 system. Because there has been substantial discussion of the inaccuracies in the D056 data (see [17] and [30], for example), Desmatics undertook an evaluation of the effects of this on the WSSC allocation of below depot maintenance labor costs. Details of that evaluation are given in Volume IV [ 9 ] of this series of reports. Basically, Desmatics found that the impact of the inaccuracies on the allocation is minimal. This section provides a summary discussion.

To gauge the effect of DLH inaccuracy on the allocation of below depot maintenance labor costs, consider a number of maintenance tasks and denote the <u>true</u> DLH expended on maintenance task i by $\mu_i$. Also denote the <u>reported</u> DLH for that task by $r_i$. In the allocation of below depot maintenance costs, ratios of the type

$$R = \sum_{1}^{k} r_i / \sum_{1}^{N} r_i$$

are used for each command/base, where $r_1, \ldots, r_k$ denote the reported DLH for the maintenance tasks for a given MDS and $r_{k+1}, \ldots, r_N$ denote the reported DLH for maintenance tasks on all other MDSs. Of course, if there is only one MDS at the CMD/GELOC, inaccuracy in the reported DLH will have no effect because all costs will always be allocated to that MDS.

However, in the case where there is more than one MDS at a CMD/GELOC, the observed ratio R may vary from the true ratio

$$U = \sum_{1}^{k} \mu_i / \sum_{1}^{N} \mu_i \ .$$

To assess the usefulness of the ratio R in this situation, a comparison was made between the value of R and the value of U, based on the assumption that for maintenance task i one of three possibilities occurs:

(1) the reported DLH is inflated so that $r_i = A\mu_i$, where $A > 1$, or

(2) the reported DLH is correct so that $r_i = \mu_i$, or

(3) the DLH for the job is unreported, i.e., $r_i = 0$.

These assumptions fit the findings of a previous Logistics study [17] which revealed through the Maintenance Data Collection system and

an inflation of reported DLH data for those jobs which were reported. An additional implicit assumption made was that, although there are inaccuracies due to misreporting, there is no bias in favor of one MDS over another at any CMD/GELOC.

In Volume V the effect of using the ratio R was examined in light of these assumptions in worst case, which is when

$$r_i = \begin{cases} A\mu_i \text{ with probability } 0.5 \\ 0 \text{ with probability } 0.5. \end{cases}$$

In this worst case, bounds on the deviation of R from U was obtained. The resulting bounds indicate that, for even a relatively small number of reported maintenance jobs (approximately 4,800 annually or 400 monthly) under worst case assumptions, there is a 95% probability that the allocation ratio used will be off by less than 0.01. Therefore, it can be concluded that the use of the below depot maintenance allocation ratios, even in the face of inaccuracies in the DLH data, provides reasonably accurate results.

## VIII. CONCLUSIONS, RECOMMENDATIONS AND OFFICE OF VAMOSC COMMENTS

This volume has discussed a number of quantitative aspects of the WSSC system and its associated data. Together with the six previous volumes in this series of reports, the current volume serves to document the results of Desmatics' evaluation of WSSC. Since this evaluation of WSSC algorithms is essentially completed, it is reasonable to provide a brief summary to put a perspective on the overall evaluation effort.

### A. SUMMARY

Desmatics has conducted an extensive, in-depth assessment of the WSSC subsystem of AF VAMOSC. This technical effort has involved detailed examination of all the algorithms and analysis of large samples of input data from most of the major systems interfacing with WSSC and VAMOH, covering four fiscal years (FY80-FY83). Desmatics has identified a number of problems (many of which confirm concerns held by the Office of VAMOSC) and has recommended appropriate solutions. These have been discussed not only in this report, but also in the preceding six volumes in this report series.

The reader is cautioned not to draw too hasty conclusions regarding the overall quality and suitability of the WSSC system and products based on a casual assessment of Desmatics findings. Certainly it would be misleading and patently unfair to weigh the shear number of Desmatics' conclusions and recommendations as an indictment of WSSC. Desmatics'

task was to identify weaknesses and suboptimum conditions so that the Office of VAMOSC could assess the cost-effectiveness of instituting changes. The Office of VAMOSC has responded positively to every recommendation and is taking steps to institute every change which, within the current bounds of its resources, can be implemented.

One general observation seems warranted. Almost all of the weaknesses identified by Desmatics are traceable to faults in the initial system design which the Office of VAMOSC inherited. Many of these design aspects represented the best a priori approximations that could be made until the system was implemented, exercised and evaluated. In other cases, however, the design philosophy was significantly flawed.

At this juncture, Desmatics feels that most of the deficiencies in the WSSC system have been identified and evaluated, in this report and in the six preceding volumes. In light of these weaknesses, the present WSSC system cannot be considered a perfect system, which is certainly not unexpected for a relatively new system. However, the WSSC framework, which is well in place, offers the potential for a very useful and necessary cost reporting system, once the steps are taken to correct the existing deficiencies. From a cost-benefit standpoint, Desmatics judges it extremely critical for the Office of VAMOSC to focus on the data selection and processing problems identified in this report.

## B. RECOMMENDATIONS AND REPLIES

This section lists Desmatics' conclusions and recommendations

with respect to the WSSC system based on the findings discussed in this report. The comments provided by the Office of VAMOSC are also included.

1. Flying Operations Ratios (See pages 16-32)

Conclusion: Desmatics has shown that flying hours and possessed hours for AF aircraft are highly correlated. This causes spurious results when attempting to derive the weighting factors used in flying operations ratios. For this reason, only one variable should be used for allocation purposes.

Recommendation: For those cost categories in which the Office of VAMOSC continues to use flying operations ratios to allocate costs, Desmatics advises using only the more significant variable (either FH or PH, depending on the cost category) rather than a combination. For any particular cost category, the variable to be used may be determined by a stepwise regression procedure, as outlined in Section IV. Although this procedure was used in conjunction with FY81-FY83 data, Desmatics suggests that the Office of VAMOSC conduct a confirmatory analysis when five years of data are available.

Office of VAMOSC Comments: "Concur. The more significant variable will be used to allocate costs. Expected implementation date is FY86."

2. Allocation of Command Staff and Other Unit Personnel (See pages 33-47)

Conclusion: An investigation by Desmatics indicates that neither flying operations ratios nor crew strength ratios provide satisfactory allocations of Command Staff and Other Unit Personnel, when compared with the "ground truth" distribution of these personnel based on PEC.

Recommendation: The Office of VAMOSC should allocate staff personnel using a technique whereby the PEC of the aircraft at a base (from AVISURS) is matched to the PEC of staff personnel at that base.

Office of VAMOSC Comments: "Concur. This office agrees there are areas here that need to be refined. We can pick up PECs without any changes to our interfacing system. We will look at matching the PEC of the aircraft at a base with the PEC of staff personnel."

3. Indirect Personnel Costs (See pages 48-56)

Conclusion: Several significant items of indirect personnel support are either not given separate visibility or are not fully costed by the WSSC system. These costs are: retirement for both military and civilian personnel, dependents' education, civilian PCS, and TDY. These should be considered in the WSSC system, in accordance with CAIG guidelines.

Recommendation: The Office of VAMOSC should include the above costs in WSSC and should provide separate visibility for the unit mission personnel portion of all indirect personnel benefits. This may be accomplished with the procedures outlined in Section VI. The costs may be presented in the Air Force detail report in a format similar to that given in Figure 3 of this volume. The portion of these costs attributable to installation support personnel should be added directly to other installation support costs.

Office of VAMOSC Comments: "Concur in part. We feel that displaying medical, military PCS and temporary duty travel under a subheading of Indirect Personnel Support on the USAF Detail Report would enhance its visibility and effectiveness. However, we do not concur that military retirement and dependents education should be considered in the WSSC system. Also, we feel there are insufficient civilian PCS moves to justify developing these costs. We will hold our final decision until further guidance from the CAIG can be obtained."

4. Appropriateness of WSSC Input Data (See pages 57-65)

Conclusion: Desmatics has determined that the one-to-one correspondence of OAC/OBAN-GELOC assumed implicitly in the WSSC system does not always occur. An OAC/OBAN may encompass several GELOCs. In addition, a given base may have more than one GELOC, which prevents both the correct allocation of installation support costs and the BOS/WSSC factor development.

Recommendation: The Office of VAMOSC should conduct in-depth studies of the input data systems H069R and E300Z to determine how their data affects WSSC algorithms with the goal being to match appropriate levels of personnel and costs. Any necessary changes should then be made to WSSC.

Office of VAMOSC Comments: "Concur. We agree that an in-depth study should be conducted and will hold further action until the results are in."

5. Missing H069R Costs (See pages 58-59)

Conclusion: Costs from the ABDS system are being lost in WSSC for MDSs whose CMD/GELOCs have no entries in the OAC/OBAN table. Also, personnel strengths and costs are rejected from the system if the CMD/GELOC has no OAC/OBAN. This causes an understatement of costs in WSSC.

Recommendation: The Office of VAMOSC should ensure that an OAC/OBAN is given for each CMD/GELOC.

Office of VAMOSC Comments: "Concur. We presently verify the OAC/OBAN/GELOC table by manually checking the OAC/OBANs sent to us from the Major Commands. When the file shows aircraft at a GELOC for which we were not given an OAC/OBAN, we then go back to the MAJCOM for clarification. As stated in Recommendation 4, we feel that the study being conducted on H069R may provide a better methodology for this process."

6. OAC/OBANs With No Costs (See pages 59-61)

Conclusion: Desmatics found a number of OBANs in the OAC/OBAN-GELOC table for MAC which had no costs in the ABDS file. Personnel strengths and costs developed from MPC data are also being rejected for these CMD/GELOCs, causing an understatement of costs for these locations.

Recommendation: The Office of VAMOSC should investigate this situation. There is a possibility that the OAC/OBANs are incorrect or that costs for these CMD/GELOCs are recorded in RC/CCs or PECs not selected by VAMOH for the WSSC system.

Office of VAMOSC Comments: "Concur. Certain MAC bases have costs which are not being entered in the ABDS file. It seems most of these OBANs are for helicopters. Desmatics, Inc. will investigate this matter in their study of H069R."

7. Additional Crew Personnel (See pages 75-76)

Conclusion: WSSC classifies many personnel in FAC 13xx as staff who, based on their AFSC, are better classified as crew. This is because WSSC only screens those personnel in FAC 31xx or FAC 37xx in the crew selection process. Such personnel in FAC 13xx may be identified by their AFSC and AFSC prefix.

Recommendation: The Office of VAMOSC should review those personnel records in FAC 13xx currently selected as staff to determine which should be considered as crew. In Desmatics' opinion, this should be at least those personnel in FAC 13xx with a valid crew AFSC or AFSC prefix of A (aircrew). Other possible crew criteria are presented in the Section VI.

Office of VAMOSC Comments: "Concur. The Office of VAMOSC will review personnel records in FAC 13xx to determine which should be considered as staff and as crew."

8. Extraneous Personnel and Costs in WSSC (See pages 65-70)

Conclusion: Desmatics has identified a number of personnel (and associated costs) in the WSSC system which are either unrelated to aircraft activities or are at a level of command which CAIG considers too high to be costed by WSSC. Personnel who should be excluded from WSSC may be identified by either PEC or FAC, and the corresponding costs by PEC or RC/CC.

Recommendation: The Office of VAMOSC should examine the three codes, RC/CC, PEC, and FAC to determine those personnel and costs which are inappropriate to consider in the WSSC system. Many of these are presented in Section VI, but this list is by no means exhaustive.

Office of VAMOSC Comments: "Concur. Our office will examine the use of RC/CC, PECs, and FACs to identify extraneous personnel."

9. Missing Personnel Costs (See pages 72-75)

Conclusion: There appear to be aircraft-related personnel at a number of bases which do not have MDSs recorded in the AVISURS system. These personnel are currently not costed by WSSC.

Recommendation: The Office of VAMOSC should investigate how personnel are recorded in MPC and how aircraft are recorded in the AVISURS system. An allocation procedure needs to be developed in order to cost these people against MDSs, as costs are understated in the WSSC system.

Office of VAMOSC Comments: "Concur. Currently we are not picking up costs from bases which have aircraft related expenses but no possessed aircraft. This is specially true of WTD bases, e.g., Aviano and Zaragoza. We are going to question HQ USAFE to see if they have a method for allocating the costs of these bases against the operational wings deploying to these locations. This would allow us to pick up and allocate the costs without changing our current logic."

10. Transient Aircraft Maintenance (See pages 71-72)

Conclusion: WSSC History file records for the maintenance costs of aircraft not possessed by the GELOC performing the maintenance (i.e., of transient aircraft) are given a GELOC of ZZZZ. This prevents GELOC-level visibility of transient aircraft maintenance.

Recommendation: The Office of VAMOSC should preserve the visibility of the GELOC performing transient aircraft maintenance (i.e., the GELOC should not be changed to ZZZZ).

Office of VAMOSC Comments: "Do not concur. Transient maintenance costs are available by MDS at the MAJCOM level. This office feels that any further delineation would serve no useful purpose."

11. Weather Squadrons (See page 75)

Conclusion: Weather services for aircraft are not being costed by the WSSC system. These costs are relevant as almost all weather services are consumed by the Air Force flying mission.

Recommendation: The operations costs and personnel of weather squadrons (RC/CC xx34xx and FAC 34xx) should be included in WSSC, and allocated to MDSs on the basis of flying hours or sorties. All aircraft, not just those in the relevant commands, must be considered when making this allocation.

Office of VAMOSC Comments: "Concur. These operations are relevant and should be costed in the WSSC system. We hope to include these by FY86 processing."

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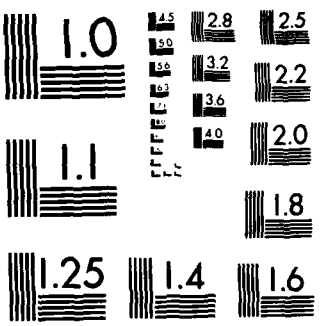

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This report presents the results of quantitative investigations conducted as part of a comprehensive evaluation of the cost allocation algorithms used in the Weapon System Support Cost (WSSC) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Cost system. WSSC displays historical operating and support (O&S) costs for existing AF aircraft. This report also presents summaries of the six previous volumes in this series. Conclusions and recommendations are included.

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